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MOSSES NEW TO CHINA FROM HEILONGJIANG AND JILIN PROVINCES

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RÉSUMÉ - Deux genres et sept espèces de mousses (Bryopsida) provenant du Nord-Est de la Chine ont été récoltés pour la première fois dans ce pays. *Psilopilum cavifolium* et *Tetrodontium repandum* ont été trouvées pour la première fois dans la région du Mont Chang Bai dans la province de Jilin. *Drepanocladus schulzei, Sphagnum flexuosum, S. lenense, S. wulfianum,* et *Tomenthypnum falcifolium* sont signalées pour la première fois dans la région de Wuying dans la province de Heilongjiang. C'est seulement la deuxième trouvaille de l'espèce *Tomenthypnum falcifolium* hors de l'Amérique du Nord. Ce sont les premières récoltes des genres *Psilopilum* et *Tetrodontium* en Chine.

ABSTRACT - Two genera and seven species of mosses (Bryopsida) are reported new to China from the northeastern portion of the country. *Psilopilum cavifolium* and *Tetrodontium repandum* are reported new from the Mt. Chang Bai area in Jilin Province, while *Drepanocladus schulzei, Sphagnum flexuosum, S. lenense, S. wulfianum,* and *Tomenthypnum falcifolium* are reported new from from the Wuying area of Heilongjiang Province. *Tomenthypnum falcifolium* is here reported for the second time outside of North America. These are the first reports of the genera *Psilopilum* and *Tetrodontium* in China.

In their Catalog of the Mosses of China, Redfearn & Wu (1986) reported just over 2000 species in 409 genera. They suggested that future field work should yield additional species and that much work remains to be done in determining relationships of species presently recorded from North America and eastern Asia. Gao (1977) reported 433 species in his moss flora of northeastern China. While studying the peatlands of northern China, we had an opportunity to make collections in both Heilongjiang and Jilin Provinces. From our collections we can report five species of mosses new to China from peat plateaus of Heilongjiang Province, and two genera new to China from the alpine tundra surrounding Mt. Chang Bai in Jilin Province. All of these species are northern or boreal in distribution, and all are known from North America. The presence of these species in northeastern China suggests that further careful search should result in additional widespread northern species being recorded from this area of China.

The specimens upon which these reports are based are deposited in ALTA, with duplicates, when present, deposited as indicated below. All collection numbers are those of the senior author.

Drepanocladus schulzei **Roth** (= *D. fluitans* var. *uncatus* Crum, Steere & Anders.). - Both of our specimens are autoicous and have well developed alar cells and reddish brown coloration. Surface water chemistry at the collecting site is characterized by a pH of 5.3, calcium content of 2.3mg/l, magnesium content of 1.6mg/l, and conductivity of 18.7μS. This species was abundant in the center of the floating mat of a thaw pocket otherwise dominated by *Sphagnum obtusum*. HEILONGJIANG PROVINCE: South slope of Xiao Xingan Mountains, 36km north of Tang Wang River on road to Tang Bai forestry camp, elevation - 580m, *34901* (IFHBH), *34958*.

Psilopilum cavifolium **(Wils.) Hag.** - This is the first report of this genus in China. Our one collection consist of several stems having imbricate, decussate leaves with entire margins and crenulate, wavy adaxial lamellae, and matches well North American specimens (Long 1985). The plants occurred on a moist, mineral soil ledge in mesic alpine tundra, associated with *Anastrophyllum assimile* and *Paraleucobryum enerve* in vegetation dominated by *Dryas octopetala*, *Rhododendron chrysanthemum*, *Aulacomnium turgidum*, and *Racomitrium lanuginosum*. JILIN PROVINCE: North slope of Mt. Chang Bai along road to crater rim, elevation 2470m, *34765*.

Sphagnum flexuosum **Dozy & Molk.** - The relatively long, blunt, stem leaves with slightly fimbriate apices are characteristics of our specimen, which was collected on minerotrophic peat beside a small spring dominated by *Brachythecium rivulare* and *Cratoneuron filicinum*. Associated species included *Sphagnum squarrosum* and *Helodium blandowii*. HEILONGJIANG PROVINCE: Yongxulinchang Forestry Camp, 10.8km north of Tang Wang River on road to Wuying, *34935* (IFSBH).

Sphagnum lenense **Lindb. *f. ex* Pohle.** - This species was found in lawns, along with *Sphagnum imbricatum (sensu lato)*, *S. magellanicum*, and *S. angustifolium* on a peat plateau dominated by *Larix dahurica*, *Ledum palustre*, and *Vaccinium uliginosum*. The occurrence of *S. lenense* at latitude of about 49 degrees North is comparable to its southernmost eastern North American station in central Quebec at 52°29'N (Gauthier 1985), but much farther south than its range in western North America (Steere 1978). In Asia, the species has an extensive distribution in arctic and subarctic portions of the Soviet Union (Smirnova 1959). She mapped its occurrence in regions just north and northeast of the present report, which is the southernmost record of the species in Asia. Its presence in this area of China may be associated with the occurrence of permafrost and the development of ombrotrophic peat plateaus. From species found in these habitats it is distinguished by the presence of sets of double pendent branches, relative small size, a copper brown color, and lacerate stem leaves that also have a deep rent for about half their length. HEILONGJIANG PROVINCE: South slope of Xiao Xingan Mountains, 36km north of Tang Wang River on road to Tang Bai fores-

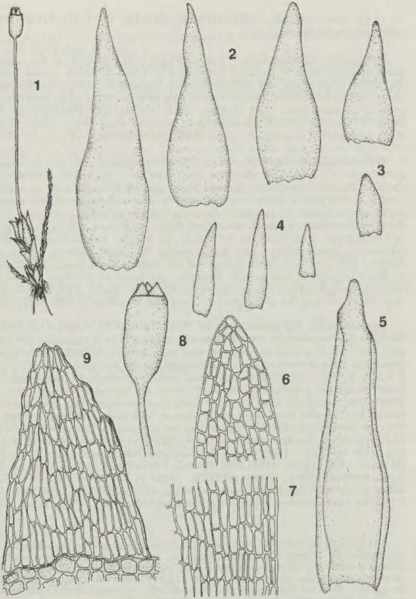

Fig. 1 - *Tetrodontium repandum* - 1: plant (x11,5), 2: stem leaves (x41), 3: basal stem leaves (x41), 4: leaves of slender branches (x41), 5: perichaetial leaf (x41), 6: upper leaf cells (x320), 7: basal leaf cells (x320), 8: capsule (x29), 9: peristome tooth (x320). Drawn from *Vitt 34759* (ALTA).

try camp, elevation 580m, *34961* (IFSBH, MO, PE, TRH, H), *34964* (IFSBH, MO), *34970* (TRH, PE, UBC).

Sphagnum wulfianum Girg. - Our specimen was collected on the sides of a small drainage ditch in peatland dominated by *Larix dahurica, Betula fruticosa, Vaccinium uliginosum,* and *Ledum palustre. Sphagnum girgensohnii* formed extensive lawns on shallow, minerotrophic peat near the edge of an ombrotrophic, permafrost dominated peat plateau. HEILONGJIANG PROVINCE: South slope of Xiao Xingan Mountains, 33km north of Tang Wang River in Hong Xing, northeast of Wuying, elevation 550m, *34894* (IFSBH, MO).

Tetrodontium repandum (Funck ex Sturm) Schwaegr. - The genus is here reported new to China. Our specimen was found on peaty soil in a small crevice formed beneath rock shelves in mesic alpine tundra. The specimen was collected nearby to *Psilopilum cavifolium* (see above). The occurrence of this species in northeastern China represents a significant range extension, otherwise known from widely scattered, mostly arctic and alpine stations in Japan, the Caucasus, central Europe, Fennoscandia, Svalbard, Jan Mayen, England, and the Pacific Northwest, Newfoundland and arctic Alaska in North America (Duell 1984, Murray 1987). The essential features of the chinese plants plants are illustrated in figure 1, and include slender branches produced at the base of the stem, ovate-lanceolate leaves, and no protonematal flaps. JILIN PROVINCE: North slope of Mt. Chang Bai along road to crater rim, elevation 2470m, *34759 c. fr.*

Tomenthypnum falcifolium (Ren. ex Nich.) Tuom. - Previously considered endemic to the boreal forest region of North America (Vitt & Hamilton 1975, Gauthier 1987), this species is here reported from eastern Asia. Recently reported from the Lake Baikal region (near Tagarkhay at 51°50'N, 102°20'E) of the U.S.S.R. by Kosovich (1989). Ecological and morphological relationships to the North American populations, and to *T. nitens* are treated separately (Vitt. et al. 1989). Our specimens were collected from four localities. The presence of this species in peatlands dominated by *Sphagnum*, with surface water chemistry indicative of either ombrotrophic bog or poor fen is similar to the habitat preferences of the species in North America. JILIN PROVINCE: Small peatland at Yuanchi, 71km southeast of Mt. Chang Bai Research Station, elevation 1250m, *34822* (IFSHB, MO), *34826*. HEILONGJIANG PROVINCE: 30km north of Hong Xing, elevation 550m, *34880* (IFSBH), *34883* (CANM, H, MO, NY, TRH); 33km north of Hong Xing, elevation 550m, *34888* (IFSBH, MO, PE), *34890* (IFSBH); 36km north of Hong Xing, elevation 580m, *34967* (MO, PE).

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EFFECTS OF SULPHUR DIOXIDE (SO_2) ON VEGETATIVE GROWTH OF TWO LIVERWORTS

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ABSTRACT - Investigations in vitro have been carried out with *Riccia discolor* and *Asterella angusta* to study the effect of sulphur dioxide (SO_2) on vegetative growth. The vegetative growth is affected by all concentrations of sulphur dioxide. At lower concentrations (0.2 and 0.5ppm) the acute injury such as discoloration, did not occur on new regenerants even after 40 and 120 hours of total exposure in both liverworts. At 1.0 and 5.0ppm regenerants were filamentous, thin, narrow and became yellow green, or pinkish in 40 and 120 hours of total exposure in both liverworts. At higher concentrations (10.0, 12.0 and 15.0ppm) acute injury such as decoloration was noted in 40 hours of total exposure, but in 120 hours, the inoculum of both liverworts became blackish and growth was completely inhibited at 12.0 and 15.0ppm. The studied growth parameters such as percentage response, number of branches, average length, fresh and dry weight productions were always maximum in control, in both liverworts. The decreased growth parameters brought about increase in SO_2 concentration and were inversely proportional to SO_2 dose, that is the concentration of SO_2 x duration of exposure.

INTRODUCTION

Bryophytes in relation to different air pollutants proved their potential as bioindicator of air pollution. Due to their habitat diversity, structural simplicity, totipotency and rapid rate of multiplication, bryophytes appear to be ideal organisms for pollution studies both under field and laboratory conditions. Influence of sulphur dioxide (SO_2) on leafy hepatics and mosses was studied by Coker (1967), Rao & Leblanc (1966), Syratt & Wanstall (1969), Comeau & Leblanc (1971), and Taoda (1973a, b) in laboratory conditions. No attempt has been made to study the effect of sulphur dioxide on thalloid liverworts. The present communication deals with the effect of sulphur dioxide (SO_2) on growth performance of *Riccia discolor* Lehm. et Lindenb. and *Asterella angusta* (Steph.) Kachroo in laboratory conditions. Both liverworts commonly grow during the rainy season in Indore. During the experiment, percentage response, number of branches, average length and fresh and dry weight production of newly formed branches per culture were noted.

MATERIALS AND METHODS

Thalli of *Asterella angusta* and *Riccia discolor* were collected from neighbouring areas of Indore (22°22'N and 75°15'E, 540m) and brought to the laboratory in polythene bags. The thalli were washed thoroughly to remove adhering soil particles. Soil free thalli were cut into 4-5mm length with a razor blade, surface sterilized with chlorinated water for 2-3 min. and washed with sterile distilled water, then planted in sterilized petridishes on sterilized Whatmann N° 1 filter paper. Ten pieces of thalli were kept in each petridish and moistened daily with sterilized Knop's solution. Petridishes were exposed for 1 and 3 hours to different concentrations of sulphur dioxide (Table 1-4) in closed fumigation chambers, according to the method of Pearson & Skye (1965), Rao & Leblanc (1966) and Coker (1967). Three replicates of ten thalli were used for each experiment. The experiments for both liverworts were conducted from 10 July 1987 to 18 August 1987. Data in tables 1 to 4 are based on 40-day-old cultures. During the growth period the petridishes were exposed daily to 10 hours light (5000 lux, maintained by an incandescent and cool white fluorescent light) and to 14 hours dark, to a temperature of 20 ± 4°C and to 80-90% humidity. Observations were made at regular intervals under a stereoscopic binocular microscope. Each datum presented in text and tables is the mean of three replicates.

SO_2 Concentration (ppm)	Percentage[1] response per culture	Number[1] of new branches per culture	Length[1] of new branches per culture (mm)	Time Taken for regenerants initiation (days)
Control	108	23	15.32	11
0.2	100	21	14.54	13
0.5	80	19	11.62	13
1.0	60	12	10.43	16
3.0	40	8	8.68	16
5.0	20	5	8.24	19
10.0	10	4	8.13	26
12.0	10	3	6.24	26
15.0	5	3	4.68	30

[1] Mean of three replicates.

Table 1 - Effect of sulphur dioxide (SO_2) on vegetative growth of *Riccia discolor* exposed daily for 1 hour (40 hours total exposure) to different concentrations of SO_2.

RESULTS

Observations on *Riccia discolor*

1. Fumigation one hour daily. - The inoculum regenerated and produced thalloid as well as filamentous regenerants. Thalloid regenerants arose mainly from the injured portions, whereas each filamentous regenerant was produced from an intact, single epidermal cell. The filamentous regenerants eventually developed into thalli. The first sign of regeneration was seen after 11 days in control. The development of new branches started from inoculum after 13 days at 0.2 and

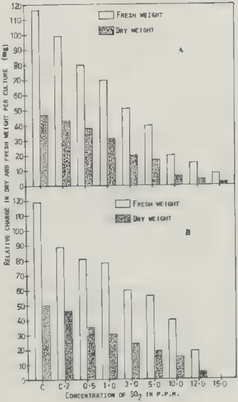

FIG. 1

Fig. 1 - Effect of different concentrations of sulphur dioxide on the production of fresh and dry weight of *Riccia discolor*. a) Exposed daily for 1 hour (40 hours total exposure), b) Exposed daily for 3 hours (120 hours total exposure).

SO_2 Concentration (ppm)	Percentage[1] response per culture	Number[1] of new branches per culture	Length[1] of new branches per culture (mm)	Time Taken for regenerants initiation (days)
Control	100	20	17.49	13
0.2	80	16	14.32	18
0.5	60	12	13.02	18
1.0	60	12	11.43	23
3.0	50	10	8.09	23
5.0	50	9	6.52	23
10.0	40	8	5.26	30
12.0	20	6	5.19	30
15.0	-	-	-	-

[1] Mean of three replicates.
\- Indicates lack of vegetative growth.

Table 2 - Effect of sulphur dioxide (SO_2) on vegetative growth of *Riccia discolor* exposed daily for 3 hours (120 hours total exposure) to different concentrations of SO_2.

0.5ppm, after 16 days at 1.0 and 3.0ppm, after 19 days at 5.0, 10.0 and 12.0ppm and after 30 days at 15.0ppm. Mean percentage response per culture was 100% in control and at 0.2ppm SO_2. Regenerants were developed in all SO_2 concentrations (Table 1), but mean number (2.3), length (15.32mm), fresh weight (116.21mg) and dry weight (47.32mg) was maximum in control (Table 1, Fig. 1A). Very low concentrations (i. e. 0.2 and 0.5ppm) inhibited growth. The increased concentrations brought about decrease in growth parameters. At higher concentrations (10.0, 12.0 and 15.0ppm) the growth of new branches was very slow and thalli showed acute injury, discoloration and developed brown to black spots on dorsal surface.

2. Fumigation three hours daily. - The first sign of regeneration was seen after 13 days and the studied parameters such as percentage response (100%), number (20), length (17.49mm), were maximum in control (Table 2). The maximum yield of fresh weight and dry weight was also in control (Fig. 1B). The development of new branches started after 18 days at levels of 0.2 and 0.5ppm. At this concentration, the new branches were narrow. At levels of 1.0, 3.0 and 5.0ppm, the new branches developed after 23 days. The regenerants were very narrow and light brown in colour. At level of 10.0 and 12.0ppm, the formation of new branches started after 30 days. At this concentration, brown to black spots developed on dorsal surface of regenerants and thalli became narrow and coiled. There was no growth at 15.0ppm, even after 40 days, and the inoculum was completely dark in colour.

Observations on *Asterella angusta*

1. Fumigation one hour daily. - The inoculum regenerated after 12 days in control and regenerants developed into healthy thalli with branches of maximum number (23), length (16.62mm), fresh weight (96.43mg) and dry weight (42.68mg) (Table 3). The inoculum regenerated after 15 days both at 0.2 and 0.5ppm, whereas it did so after 20 and 23 days at 1.0 and 3.0 ppm, respectively. At 5.0ppm, inoculum produced after 28 days numerous narrow, thin, yellow-green and sparingly branched regenerants. At 10.0 and 12.0 ppm, all filamentous regenerants were short, light yellow with wavy pinkish and incurved margin after 31 days. At 15.0ppm, growth and differentiation were suppressed markedly; the thalli were very short with brown-black spots on dorsal surface. The growth parameters were minimum at 15.0ppm (Table 3, Fig. 2A).

2. Fumigation three hours daily. - The inoculum regenerated after 12 days in control and produced thalloid as well as filamentous regenerants. Filamentous regenerants eventually developed into thalli. The percentage response (100%), number (26), length (17.43mm) was maximum per culture in control (Table 4) and maximum fresh and dry weight yields were obtained (Fig. 2B). The time taken for regeneration ranged from 19 days at 0.2 and 0.5ppm, 26 days at 1.0 and 3.0ppm, 30 days at 5.0ppm, to 34 days at 10.0ppm. At 12.0 and 15.0ppm the inoculum showed no regenerants even after 40 days. At 0.2 and 0.5ppm, a few thick, green, thalloid regenerants were seen that showed very poor growth. At 1.0 and 3.0ppm, very few thalli were produced. They turned yellowish green and formed a large number of filamentous regenerants. At 5.0ppm, a few narrow, thin and pinkish green regenerants were produced. At 10.0ppm, 4-5 thin, narrow

SO_2 Concentration (ppm)	Percentage[1] response per culture	Number[1] of new branches per culture	Length[1] of new branches per culture (mm)	Time Taken for regenerants initiation (days)
Control	100	23	16.62	12
0.2	90	21	14.01	15
0.5	90	17	10.53	15
1.0	70	15	8.02	20
3.0	60	12	6.89	23
5.0	50	10	5.24	28
10.0	30	7	4.33	31
12.0	20	[illegible]	3.76	31
15.0	20	4	3.39	33

[1] Mean of three replicates.

Table 3 - Effect of sulphur dioxide (SO_2) on vegetative growth of *Asterella angusta* exposed daily for 1 hour (40 hours total exposure) to different concentrations of SO_2.

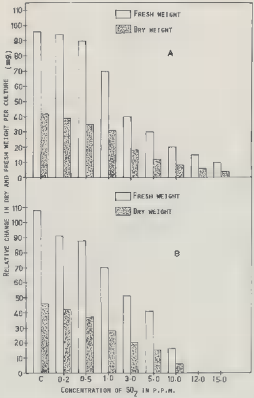

FIG. 2

Fig. 2 - Effect of different concentrations of sulphur dioxide on the production of fresh and dry weight of *Asterella angusta*. a) Exposed daily for 1 hour (40 hours total exposure), b) Exposed daily for 3 hours (120 hours total exposure).

coiled regenerants with black spots were produced. The percentage response (20%), number (4), length (3.73mm), fresh weight (15.61mg) and dry weight (5.89mg) were minimum at 10.0ppm (Table 4, Fig. 2B).

DISCUSSION

Bryophytes are reliable indicators and monitors of air pollution, provided the metabolic responses to various levels and kinds of pollutants under different ecological conditions were clearly deciphered and properly understood through controlled experiments (Rao & Leblanc 1966, Coker 1967, Syratt & Wanstall 1969,

SO_2 Concentration (ppm)	Percentage[1] response per culture	Number[1] of new branches per culture	Length[1] of new branches per culture (mm)	Time Taken for regenerants initiation (days)
Control	100	26	17.43	12
0.2	90	18	13.52	19
0.5	70	14	12.62	19
1.0	50	10	10.82	26
3.0	40	8	7.23	26
5.0	30	5	4.92	30
10.0	20	4	3.73	34
12.0	-	-	-	-
15.0	-	-	-	-

1 Mean of three replicates.
- Indicates lack of vegetative growth.

Table 4 - Effect of sulphur dioxide (SO_2) on vegetative growth of *Asterella angusta* exposed daily for 3 hours (120 hours total exposure) to different concentrations of SO_2.

Taoda 1973b). Taoda (1973b) found that most bryophytes were injured at 0.8ppm SO_2 in 10-40 hours, or at 0.4ppm in 20-80 hours of total exposure. The present experimental results on growth of *Riccia discolor* and *Asterella angusta* demonstrate that those species were greatly affected by SO_2. At 1.0, 3.0 and 5.0ppm, new regenerants of both liverworts were injured in 40-120 hours of total exposure. The new regenerants were very narrow, short, filamentous, thin and yellow green, light brown or pinkish green in colouration. At 0.2 and 0.5ppm, acute injury such as discoloration, did not occur on new regenerants even after 120 hours of total exposure, but chronic injury such as growth retardation was noted in both liverworts. The growth parameters such as percentage response, length, number (Table 1-4), fresh weight and dry weight (Fig. 1 & 2) was significantly higher at 0.2 and 0.5ppm than at 1.0, 3.0 and 5.0ppm. Syatt & Wanstall (1969) studied the effect of 5ppm SO_2 on chlorophyll breakdown of bryophytes such as *Dicranoweisia cirrata, Metzgeria furcata, Hypnum cupressiforme.* They found that damage to chlorophyll showed dependence on the humidity at which SO_2 is supplied; the higher the humidity the greater the damage. In the present experiments, petridishes containing thalli were exposed daily to SO_2 when relative humidity was 80-90%. It is possible that the growth parameters are affected by relative humidity. The morphology of new thalli of both liverworts was drastically altered at high concentrations, at 40 and 120 hours of total exposure. At higher concentrations (10.0, 12.0 and 15.0ppm) and 40 hours of total exposure, the new regenerants of both liverworts showed acute injury, discoloration, brown to black spots on dorsal surface. The growth parameters decreased in comparison to the lower concentrations (Table 1-4, Fig. 1 & 2). At 120 hours of total exposure, *Riccia discolor* survived at 10.0 and 12.0 ppm but no regenerants were produced at 15.0ppm. At 10.0 and 12.0ppm regenerants were very short, narrow, thin, coiled and developed abundant black spots on dorsal surface. The inoculum at 15.0ppm was completely covered by a dark layer. *Asterella angusta* survived only at 10.0ppm and produced 4-5 thin, narrow coils with blackish regenerants. No regenerants developed at 12.0 and 15.0ppm, even after 40 days. The inoculum was covered by a blackish layer. The present experimental results indicate that the vegetative growth of *Riccia discolor* and *Asterella angusta* were affected by almost all SO_2 concentrations. Comeau & Leblanc (1971) examined the regenerative power of *Funaria hygrometrica* leaves exposed to 0.5, 1.0, 5.0 and 10.0ppm of SO_2 concentrations for 4, 6 and 8 hours duration, and compared the regenerative capacity of fumigated and unfumigated leaves. They found that the regeneration percentage was more or less inversely proportional to the pollution dose. Present finding on *Riccia discolor* and *Asterella angusta* are in agreement. The growth parameters such as percentage response, number, length, fresh and dry weight production were always maximum in control (unfumigated) in both liverworts (Table 1-4 and Fig. 1, 2). In fumigated, the growth parameters decreased with increase in SO_2 concentrations from 0.2 ppm to onwards, and were inversely proportional to pollution dose, that is the concentration of SO_2 x duration of exposure.

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OREOWEISIA EROSA (C. MUELL.) KINDB., AN AFRICAN-NEOTROPICAL DISJUNCT

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ABSTRACT - A reevaluation of *Oreoweisia erosa* (C. Muell.) Kindb. and *O. lechleri* (C. Muell.) Par. confirms that they are geographical synonyms. The range includes Mexico, Venezuela, Colombia, Peru, Bolivia and southern Africa. *Oreoweisia erosa* is the older name.

In a recent review of the neotropical species of *Oreoweisia* (Griffin 1986), a question arose concerning the possible conspecificity of *O. lechleri* (C. Muell.) Par. and the African species *O. erosa* (C. Muell.) Kindb. While several collections of *O. lechleri* were available for study, only two African collections of *O. erosa* could be examined at the time, and a decision on any putative synonymy was deferred.

Now, through a generous loan of African collections by the Missouri Botanical Garden and of the type for *O. erosa* by the British Museum, I am in a position to assert that *O. lechleri* and *O. erosa* are geographical synonyms for the same species. The New World range, as presently known, includes Mexico, Venezuela, Colombia, Peru and Bolivia. In Africa it is recorded from Zaire, Lesotho and South Africa. New World populations vary more in height of leafy plants compared with African populations, but overlap in this and several other characters (e.g., leaf length, shape, size and degree of bulging of laminal cells, seta length, capsule shape and size, spore size and ornamentation) is sufficiently great throughout the distribution that no clear distinction can be made between neotropical and African plants. This conclusion is at odds with that of Mueller (1862) who found African plants of *O. erosa* to be more robust with narrower leaves that were never serrate and had a minute, incrassate areolation in comparison with plants of *O. lechleri*.

A full description for this species, together with a listing of all synonyms, follows:

Oreoweisia erosa (C. Muell.) Kindb., Enum. Bryin. Exot. 69. 1888.

Weissia erosa Hampe *ex* C. Muel., *Bot. Zeitung (Berlin)* 16: 163. 1858.
Weissia lechleri C. Muell., *Bot. Zeitung (Berlin)* 20: 350. 1862, **syn. nov.**
Weissia lechleri var. *minor* C. Muell., *Bot. Zeitung (Berlin)* 20: 350. 1862, **syn. nov.**
Weissia bogotensis Hampe, *Linnaea* 32: 131. 1863, **syn. nov.**
Oreoweisia ampliata Mitt., *J. Linn. Soc. Bot.* 12: 53. 1869, **syn. nov.**
Oreoweisia bogotensis (Hampe) Mitt., *J. Linn. Soc. Bot.* 12: 53. 1865, **syn. nov.**
Oreoweisia ligularis Mitt., *J. Linn. Soc. Bot.* 12: 53. 1869, **syn. nov.**
Weissia auridens C. Muell., *Linnaea* 43: 436. 1882, **syn. nov.**
Oreoweisia lechleri (C. Muell.) Kindb., Enum. Bryin. Exot. 69. 1888, **syn. nov.**
Oreoweisia lechleri C. Muell. var. *minor* (C. Muell.) Par. Index Bryol. 868. 1894, **syn. nov.**

Plants in loose to ± dense tufts, dark-green to yellow-brown, 0.2-3cm high, stems erect, simple or fastigiate, radiculose below; roundish in cross-section with a central strand, inner cortical cells large, lax, hyaline, outer 1-3 cortical rows of incrassate, reddish cells; axillary hairs of 6-8 elongate cells, hyaline throughout. **Leaves** contorted-incurved when dry, spreading when wet, narrowly ovate-ligulate, carinate, apex obtuse to acute, 1.3-3.5mm long; margins plane above, entire to erose-dentate or serrulate, recurved below, entire; costa strong, subpercurrent to, less frequently, percurrent, 75-110μm wide at base, elliptic in cross-section, with 4(-6) guides and a dorsal stereid band, stereids numerous at extreme base, few near apex of costa; upper laminal cells dense to pellucid, subquadrate to rounded-quadrate or rounded-triangular, frequently oblate, often in distinct rows, conic-mammillose to low conic-bulging on both sides, firm-walled, 6-15μm in greatest diameter, inner basal cells lax, hyaline, rectangular to long-rectangular, smooth, alar region not differentiated, basal marginal cells short-rectangular to rectangular. **Autoicous. Perichaetial leaves** not differentiated. **Setae** erect, twisted, 4-8mm long; **capsules** erect, symmetric, ovoid to ovoid-short cylindric, smooth, 1-1.8mm long, median exothecial cells oblong-rectangular, firm-walled to incrassate, 15-20μm wide, 25-60μm long, projecting at ends; peristome single, inserted below the mouth, teeth fragile, 175-275μm long, lanceolate-subulate, smooth, orangish below, hyaline to light yellow above, entire, perforated or cleft to middle or below, forks ± equal to quite unequal; opercula conic-rostrate, beak oblique. **Calyptrae** cucullate, smooth, glabrous. **Spores** roundish, finely papillose, 17-27μm in diameter.

Collections of *Oreoweisia erosa* have a relatively uniform morphology over the entire known range. Such variation as does occur seems not to have a geographical component, an observation that could suggest that the African-neotropical disjunction is of relatively recent occurrence. The species would appear to be restricted to shrub-cloud forest ecotones, shrub paramos and montane grasslands. Plants grow on rocks or, occasionally, on soil. Leaf apices may vary, often within the same collection or on the same plant, from obtuse to acute with upper margins varying from entire to erose-dentate or serrulate. Upper laminal cells may appear dense and high conic-mammillose or pellucid and low conic-bulging. Considerable variation is seen in the degree of perforation and clefting of the peristome teeth. This is a feature that typifies several species of the genus. Brotherus (1924) described the peristome of *Oreoweisia* as *ungeteilt*, but this is misleading since, as Casares-Gil (1932) noted and illustrated in relation to the peristome of *O. bruntonii* (Sm.) Mild., both entire and forked teeth occur. The same is true of *O. erosa*.

The present known range of *O. erosa* is almost certainly incomplete, preventing a detailed analysis of the factors that might explain the disjunct character. Buck and Griffin (1984) reviewed a number of bryophyte taxa with African-South American disjunctions and managed to arrange the species into 3 ecological habitat categories, *viz.*, lowland-lower montane, montane to paramo/elfin forest and austral-temperate and/or antipodal taxa. *Oreoweisia erosa* fits comfortably into the montane to paramo/elfin forest category across most of its New World distribution and at the northern end of the African range in Zaire. But in Mexico, and in the southern part of the African distribution, the species occupies upper elevational grasslands. This shift in ecology from quasi-forested habitats to grassland is interesting, inviting speculation about the evolutionary history of the species. Since most contemporary species of the genus appear to grow in or near cloud forest/montane shrub ecotones, it is reasonable to project a humid arborescent vegetation as reflective of the ancestral niche. Accepting this presumed historical ecology, invasion of montane grasslands would tend to be viewed as a derived migration, *O. erosa* being one of the few extant species able to survive in a more exposed habitat. However, nothing is known of the age of this taxon, and so it is equally plausible that the present-day grasslands where *O. erosa* is found were forested in the geological past, in which case the occurrence of this species in such environments might better be judged as relictual. If it were possible to assess whether the range of *O. erosa* is expanding or contracting, especially in the grasslands, it might provide a clue as to which of the evolutionary histories is the more probable. An expanding grasslands range would suggest a more recent invasion by a weedy species whereas a stable or contracting grasslands range might suggest a relictual species surviving in an increasingly hostile habitat.

Specimens examined. - ZAIRE. Kivu, piste du Kahuzi, 2720m, J.-L. De Sloover 12712 (MO, FLAS), Parc National du Kahuzi-Brega, 2760m, J.-L. de Sloover (MO, FLAS). LESOTHO. Sehlabathebe National Park, R.E. Magill 4307 (MO), Sani Pass, R.E. Magill 4486 (MO). SOUTH AFRICA. Cape Prov., Ecklon *s.n.* (type- BM!), Table Mt., E. Esterhuysen 15365 (MO), 15432 (MO). Orange Free State, 31km N.E. of Verkykerskop, S.M. Perold 1272 (MO).

MEXICO. Estado México, Volcán Ixtaccihuatl, J. Rzedowski 21783 (FLAS). VENEZUELA. Táchira, páramo La Negra, 2600m, Griffin, López F. & L. Ruiz-Terán 21 (MERF, FLAS), páramo El Batallón, 3350m, Griffin, López F. & L. Ruiz-Terán 545 (MERF, FLAS). Trujillo, páramo El Jabón, 3000m, Griffin & Lopez F. PV-1352 (MERF, FLAS). COLOMBIA. Caldas, Nevado del Ruíz, 4300m, Cleef & H. 't Hart 2533 (U, FLAS). PERU. Ancash, Huascarán National Park, 3850m, Smith C617 (MO). BOLIVIA. Am Tunarisee, ca. 4400m, Th. Herzog 4892 (L).

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OBSERVATIONS SUR LA STRUCTURE DE LA PAROI ET DE L'APERTURE DE LA TÉTRASPORE DE *SPHAGNUM FIMBRIATUM* WILSON

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RÉSUMÉ - L'existence d'une couche séparatrice située entre l'exine "a" lamellaire et l'intine est mise en évidence chez *Sphagnum fimbriatum* Wilson. La couche séparatrice en s'épaississant fortement au niveau de l'aperture, donne naissance aux bourrelets aperturaux. Cette couche surépaissie est traversée par une remontée de l'intine qui rejoint la base de l'exine "a", juste sous le sillon apertural. Ces nouveaux éléments d'observations chez *S. fimbriatum* s'intègrent parfaitement aux résultats cytologiques obtenus chez *Sphagnum lescurii* Sull. par Brown & al.

ABSTRACT - A separative layer is shown to exist between the lamellate exine "a" and the intine in *Sphagnum fimbriatum* Wilson. This separative layer is getting thicker at the aperture level and is often the origin of the apertural thickenings. In this thicker part, it is interrupted by the intine that meet again exine "a" under the apertural ridge. These new data for *Sphagnum fimbriatum* are in accordance with the cytochemical results published by Brown & al. for *Sphagnum lescurii* Sull.

INTRODUCTION

Les sphaignes possèdent des spores hétéropolaires dont la face proximale tétraédrique porte une aperture de type trilésuré bien mise en évidence chez de nombreuses espèces par les observations en microscopie à balayage (Cao & Vitt 1986).

Brown & al. (1982 a et b) ont pu établir, à partir de recherches effectuées en microscopie à transmission sur *Sphagnum lescurii* Sull., que la paroi sporale des sphaignes apparaît constituée de 5 couches qui sont respectivement: l'intine (la couche la plus interne), l'exine "a" d'aspect lamellaire, l'exine "b" homogène, la couche translucide et, à la périphérie, la périne. Au niveau de l'aperture, ces auteurs ont montré que l'organisation structurale des différentes couches subissait

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Travaux réalisés au Laboratoire de Cryptogamie Ultrastructurale de l'E.P.H.E. (Muséum d'Histoire Naturelle), dans le cadre d'une thèse E.P.H.E. soutenue le 26 mai 1987.

de profondes modifications, avec, notamment, la formation de dépressions caractérisant les sillons aperturaux. Ces dépressions sont dues à l'absence de la périne, de la couche translucide et à la quasi disparition de l'exine "b" avec, de part et d'autre du sillon, l'existence de bourrelets issus de l'épaississement de l'intine.

Nous apportons ici les résultats de nos propres investigations réalisées au M.E.T. sur le sporogone de *Sphagnum fimbriatum* Wilson, que nous comparons aux résultats de Brown & al. (1982 a et b).

MATÉRIEL ET MÉTHODE

Les modalités de récolte et de traitement de *Sphagnum fimbriatum* ont été développées dans un article précédent (Boudier 1988).

RÉSULTATS

Au cours du stade tétrade, chacune des 4 spores issues de la double division de la cellule mère élabore sa propre paroi. Pour cela, le plasmalemme met en place une couche trilamellaire (Brown & al. 1982a) qui, par divisions successives, aboutit à la formation d'une couche multilamellaire (fig. 1 et 2): c'est l'exine "a" lamellaire (Ea) qui constitue la trame primordiale de la formation de la paroi sporale. De part et d'autre de cette couche se développent simultanément (fig. 3 et 4):

- du côté interne et de façon centrifuge, une couche élaborée par le plasmalemme d'aspect fibrillé et assez transparente; c'est l'intine;

- du côté externe, et de façon centripète, une couche fibrillée épaisse, dense aux électrons, apparaissant à un certain stade de sa constitution plus ou moins hétérogène; c'est l'exine "b".

De plus, il est possible de mettre en évidence, entre l'exine "a" et l'intine, une couche peu épaisse, très dense aux électrons, que nous nommons la couche séparatrice (fig. 3, 4 et 5). Son origine n'a pas été établie avec certitude; on note en particulier des phénomènes de pénétrations manifestes de lamelles de l'exine "a" dans la couche séparatrice (flèches de la figure 5) ce qui permet d'envisager une étroite relation d'origine avec l'exine "a".

Au cours de la phase finale du stade tétrade (fig. 6 et 7), l'exine "a" forme une couche lamellaire continue et d'épaisseur constante tout autour de la spore. L'exine "b" présente au pôle distal de fortes variations d'épaisseur tandis qu'au pôle proximal, de part et d'autre du sillon apertural, elle reste d'épaisseur constante.

Par contre au niveau de l'aperture, ces différentes couches s'organisent selon une stratification toute particulière. En effet, seule l'exine "a" lamellaire ne subit aucune modification dans sa structure et son épaisseur: elle suit exactement les ondulations pariétales créées par les bourrelets aperturaux. L'exine "b", au contraire, disparait presque complètement au niveau du sillon apertural pour n'y figurer qu'à l'état d'une mince couche. La couche séparatrice s'épaissit fortement et se trouve être à l'origine de la formation des bourrelets aperturaux. L'intine, sous le sillon apertural, se prolonge à travers la couche séparatrice très épaisse pour venir au contact de la base de l'exine "a". Cet agencement structural des différentes couches est bien mis en évidence dans les coupes équatoriales pratiquées dans l'aperture (fig. 6 et 7). Ces documents montrent que les bourrelets aperturaux résultent d'un développement important et localisé de la couche séparatrice dont le fort contraste aux électrons par rapport à la transparence de l'exine "a" rend l'individualisation particulièrement nette au M.E.T.

A un stade plus avancé de l'évolution de la spore (stade jeune spore libre), cet agencement des différentes couches au niveau de l'aperture est toujours visible (fig. 8), avec, en plus, acquisition de la couche translucide (Ct) et de la périne (Per.). Comme chez *S. lescurii*, ces deux couches sont absentes au niveau du sillon apertural. Chez *S. fimbriatum* la couche translucide se révèle moins épaisse.

DISCUSSION

Chez *S. fimbriatum*, nous avons retrouvé au sein de la paroi sporale en formation l'ensemble des différentes couches décrites par Brown & al. (1982 a et b) chez *S. lescurii* et, chez ces deux sphaignes, la genèse des couches pariétales semble suivre le même processus.

Cependant, nous avons pu préciser l'existence, chez *S. fimbriatum*, d'une couche séparatrice peu épaisse, très opaque aux électrons et située entre l'exine "a" lamellaire et l'intine. Cette formation présente un développement très important au niveau de l'aperture. Elle est à l'origine des bourrelets aperturaux formant les trois crêtes qui donnent son aspect triradié caractéristique à la face proximale de la spore des sphaignes.

A partir de leurs observations sur *S. lescurii*, Brown & al. (1982b) ont défini une "intine" correspondant à la formation située sous l'exine "a" lamellaire. D'après leur analyse cytochimique, ils ont pu montrer l'hétérogénéité de cette couche dans laquelle 2 zones peuvent être distinguées:

- d'une part, une couche supérieure, en contact avec l'exine "a" lamellaire, qui se caractérise par de nombreux globules résistant à l'acétolyse. C'est cette formation qui se présente sur nos documents très dense aux électrons et que nous définissons comme étant la couche séparatrice (Cs).

- d'autre part, une couche inférieure sans globules acétorésistants et relativement transparente aux électrons. Elle correspond à l'intine telle que nous la définissons.

Au niveau de l'aperture, ces auteurs ont noté le fort épaississement de cette même formation riche en globules acétorésistants qui se localise au-dessous des crêtes de l'aperture trilésurée, là où nous avons observé un important épaississement de la couche séparatrice. De plus, ils ont remarqué l'absence de tels globules juste sous le sillon apertural où nous avons mis en évidence la remontée de l'intine à travers les bourrelets aperturaux.

Nos résultats concordent largement avec l'ensemble des analyses cytochimiques réalisées par Brown & al. (1982 b). Toutefois, nous sommes amenés à définir au sein de l'intine telle que l'ont décrite ces auteurs, d'une part, une couche séparatrice occupant la partie en contact avec l'exine "a" lamellaire et, d'autre part, dans la partie sous-jacente, l'intine proprement dite.

L'origine de la couche séparatrice n'a pu être précisée. En effet, il est difficile d'affirmer que cette couche trouve l'intégralité de son origine dans le seul développement du plasmalemme, nos documents ne permettant pas de trancher définitivement sur ce point. Toutefois, la présence de lamelles de l'exine "a" pénétrant la couche séparatrice indique l'étroite relation existant entre ces deux formations. On peut envisager que la couche séparatrice trouve son origine dans une différenciation interfaciale secondaire au contact des éléments structuraux de l'intine et de la partie inférieure de l'exine "a". Il semble préférable de conserver à cette formation son individualité.

CONCLUSION

D'après les travaux de Brown & al. (1982 a et b) et à la suite de nos propres observations, il devient donc possible de reconnaître dans la paroi sporale de *S. fimbriatum* (et certainement dans l'ensemble du genre *Sphagnum*), l'existence de 6 couches, à savoir successivement de l'intérieur vers l'extérieur:

- l'intine
- la couche séparatrice
- l'exine "a" lamellaire
- l'exine "b"
- la couche translucide
- la périne

L'agencement structural très spécifique de ces différentes couches au niveau de l'aperture, et en particulier la présence d'une remontée de l'intine sous le sillon aperturaI, crée une zone privilégiée propice aux actions enzymatiques de dissolution dans le cadre du processus de rupture de la paroi sporale lors de la germination.

Ces nouvelles observations nous ont convaincus de la nécessité d'orienter nos recherches futures sur la cytologie des parois à cette phase importante du développement que constitue le processus de germination de la spore avant les premiers cloisonnements.

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LÉGENDES DES PLANCHES

Abréviations:

bA: bourrelet apertural - Cs: couche séparatrice - Ct: couche translucide - Cy: cytoplasme - E: exine - Ea: exine "a" - Eb: exine "b" - I: intine - Li: lipide - PaTe: paroi de la tétrade - Per: périne - Plm: plasmalemme - sA: sillon apertural - Tsp: tétraspore.

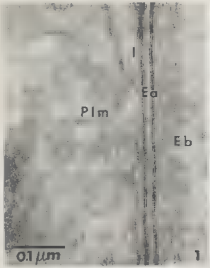
Fig. 1 à 4: Initiation de la paroi sporale au début du stade tétrade. - 1: Développement de l'exine "a" (Ea) multilamellaire à partir du plasmalemme (Plm). 2: Détail de l'exine "a" (Ea) montrant sa structure multilamellaire. 3: Invagination du plasmalemme (Plm) avec début de formation de l'intine (I) et de l'exine "b" (Eb) de part et d'autre de l'exine "a" (Ea). Début de différenciation de la couche séparatrice (Cs) à la base de l'exine "a". 4: Croissance de la paroi: développement de l'intine (I), de la couche séparatrice (Cs) et de l'exine "b" (Eb) qui présente des discontinuités. (M.E.T. Double fixation glutaraldéhyde et tétroxyde d'osmium. Double contraste acétate d'uranyle et citrate de plomb).

Fig. 5: Stade tétrade plus âgé. Coupe au niveau d'une ondulation de la paroi. L'exine "b" (Eb) est plus homogène et a subi une forte croissance alors que l'exine "a" (Ea) conserve son aspect lamellaire et que son épaisseur reste stable. Entre l'exine "a" (Ea) et l'intine (I) qui poursuit son développement, la couche séparatrice (Cs) se révèle être très dense aux électrons. On remarque des pénétrations de lamelles de l'exine "a" dans la couche séparatrice (flèches). (M.E.T. Double fixation glutaraldéhyde et tétroxyde d'osmium. Double contraste acétate d'uranyle et citrate de plomb).

Fig. 6: Stade tétrade final. Coupe d'une tétraspore passant par les pôles proximaux et distaux. A noter l'épaisseur constante de l'exine "b" (Eb) de part et d'autre du sillon apertural, par contre sa grande variation en épaisseur au pôle distal. Les lipides de réserve commencent à être stockés. (M.E.T. Double fixation glutaraldéhyde et tétroxyde d'osmium. Double contraste acétate d'uranyle et citrate de plomb).

Fig. 7: Stade tétrade final. Trois des quatre tétraspores bien formées, encore limitées par la paroi de la tétrade (PaTe), avec leur aperture se faisant typiquement face. On distingue l'épaississement de la couche séparatrice formant les bourrelets aperturaux (bA) et sous-jacente, d'aspect moins contrasté, l'intine (I) qui remonte sous le sillon apertural (sA). (M.E.T. Double fixation glutaraldéhyde et tétroxyde d'osmium. Double contraste acétate d'uranyle et citrate de plomb).

Fig. 8: Stade jeune spore libre. L'aperture est toujours très nettement structurée. Se superposant à l'exine "b" (Eb), on note l'existence d'une couche mince d'aspect clair, la couche translucide (Ct), et au-dessus, un dépôt discontinu, dense aux électrons, formant les premiers éléments non structurés de la périne (Per). (M.E.T. Double fixation glutaraldéhyde et tétroxyde d'osmium. Double contraste acétate d'uranyle et citrate de plomb).


I
Ea
Plm
Eb
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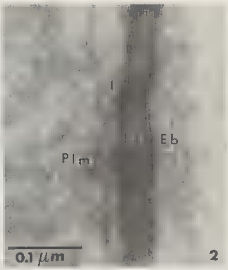
1


I
Eb
Plm
0.1 μm
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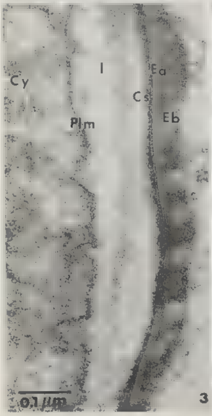
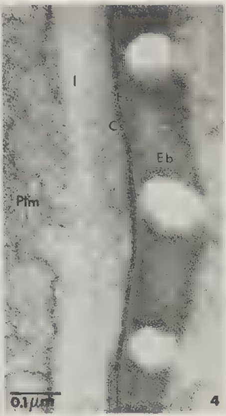

I
Ea
Cy
Cs
Plm
Eb
0.1 μm
3


I
Cs
Eb
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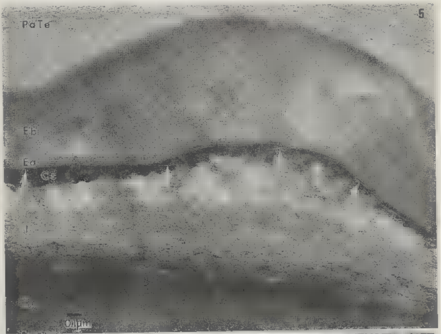
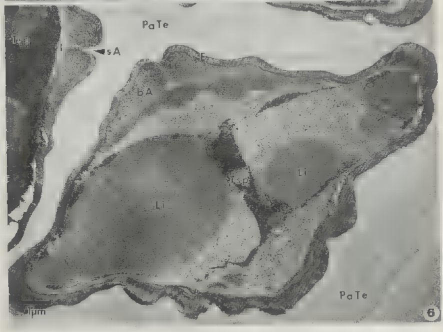
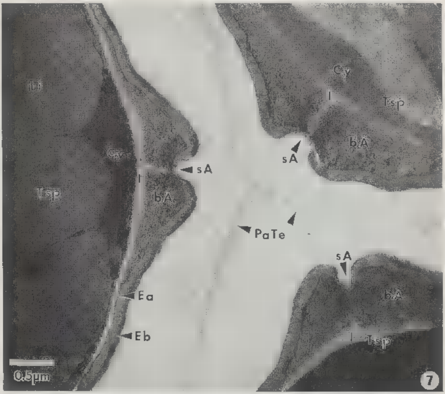
0.1 μm
4


5
PaTe
Eb
Ea
Ce
I
0,1µm


PaTe
I
sA
E
bA
Sp
Li
Li
PaTe
1µm
6


Cy
l
Tsp
bA
sA
Cy
Tsp
l
bA
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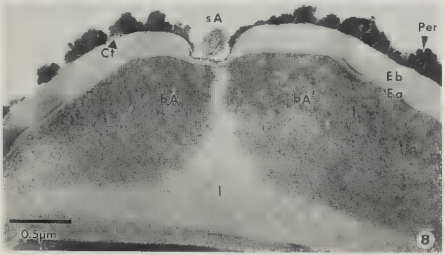
sA
PaTe
sA
bA
Ea
Eb
l
Tsp
0.5µm
7


sA
Per
Ct
Eb
Ea
bA
bA
l
0.5µm
8

Cryptogamie, Bryol. 1989, 10 (4): 309-312

LES LICHENS ÉPIPHYTES DU PIN NOIR A LARRA (NAVARRE, ESPAGNE)

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RÉSUMÉ - Étude d'une pinède pyrénéenne à *Pinus uncinata* Miller ex Mirbel., située entre 1400 et 2000m, très riche en lichens. Les espèces intéressantes pour la flore ibérique sont signalées dans le résumé anglais.

ABSTRACT - A pyrenean pinewood of *Pinus uncinata* Miller ex Mirbel., situated between 1400 and 2000m, very rich in lichens, has been studied. Among the interesting species for the Iberian flora, we noted: *Calicium denigratum* (Vain.) Tibell, *Cladonia sulphurina* (Michx.) Fr., *Hypocenomyce sorophora* (Vain.) P. James & Poelt, *Lecanora sarcopidioides* (Massal.) A. L. Sm., *Lecidea pullata* (Norm.) Th. Fr., *Lecidea subfuscescens* Vain., *Mycoblastus affinis* (Schaerer) Schauer, etc.

La pinède de pin noir *(Pinus uncinata* Miller ex Mirbel) étudiée occupe une aire réduite à l'extrême nord-est de la province de Navarre, en limite avec la province de Huesca et avec la France (quadrillage U.T.M. 30T XN75). La partie échantillonnée comprend les environs de Leja, de La Contienda et de Laizerola et s'étend jusqu'aux environs de la Pierre-de-St.-Martin, située à la frontière même.

La morphologie des karsts de Larra est rès particulière car elle est parsemée de crêtes calcaires et de dépression ou de thalwegs. Sur les premières, enraciné dans des crevasses et diaclases à sol squelettique, pousse le pin noir, tandis que dans les zones plus favorisées à sol profond, on peut trouver des petites étendues de hêtraie-sapinière.

Les précipitations annuelles sont très élevées et varient entre 1800 et 2000mm, sous forme de pluies et principalement de neige. La neige conditionne fortement la végétation car elle reste pendant plusieurs mois (de novembre à juin) spécialement dans les zones défavorisées et ombragées (glaciers). En outre les gelées se produisent durant la même période. Les orages sont fréquents. La foudre et les vents forts abattent les troncs de pin noir les plus exposés. Les brouillards ont aussi une grande importance sur la flore lichénique car ils imprègnent quotidiennement cette forêt peu dense.

La température moyenne annuelle est très basse, proche de 0°C; de plus, le relief karstique, varié, modifie le climat général en créant des différences de température atteignant 10°C entre zones ombragées et zones ensoleillées.

La station de lichens épiphytes sur *Pinus uncinata* étudiée se situe entre 1400 et 1800m. A une altitude plus basse, le pin noir cohabite avec la hêtraie-sapinière qui présente un flore de lichens beaucoup plus riche, que nous nous proposons d'étudier dans des travaux postérieurs. Cette forêt commence à disparaître dès 1700m et, de cette altitude à 2000m, seuls les pins survivent.

Llimona (1976), dans le cadre d'un plus vaste projet, a recueilli certaines des espèces les plus fréquentes dans la zone (signalées par un astérisque dans la liste ci-après). Etayo Salazar (1986, 1988) cite aussi quelques taxons de Larra.

Nous avons récolté soixante dix espèces pendant les étés 1986-1987, que nous avons classées selon trois types de substrats: troncs vivants, branches et bois. Ce dernier type de support héberge une flore intéressante dont la nature dépend principalement de trois facteurs: tronc décortiqué, debout ou au contraire abattu, exposition et degré plus ou moins avancé de décomposition du bois.

Dans la liste qui suit, l'abondance de chaque espèce est indiquée par les lettres suivantes: CC, très abondante, C, commune, R, rare et dispersée, RR, très rare (trouvée une seule fois). La nature du substrat est exprimée par:

1. Base du tronc vivant - 2. Partie moyenne du tronc. - 3. Branches. - 4. Tronc mort, debout et décortiqué (bois dur et sec). - 5. Base de troncs morts et fûts tombés (bois humide). - 6. Souches en état avancé de décomposition.

Un point d'exclamation (!) précédant un binôme signale la rareté de ce taxon, nouveau pour la Péninsule ibérique; un astérisque (*) indique que l'espèce est nouvelle pour la Navarre.

Espèces se rencontrant principalement sur tronc

Fuscidea cyathoides (Ach.) V. Wirth & Vezda - RR, 2.
! *Hypogymnia* cf. *austerodes* (Nyl.) Räs. - R, 2. Arctique, Scandinavie et Alpes continentales (Poelt & Vezda 1977).
H. bitteriana (Zahlbr.) Räs. - C, 2, 3.
Imshaugia aleurites (Ach.) Fricke Meyer - CC, 1, 3.
Lecidea hypnorum Libert - RR, 1.
Lepraria incana (L.) Ach. - R, 1.
* *Mycoblastus sanguinarius* (L.) Norm. - R, 2, 4.
Ochrolechia alboflavescens (Wulf.) Zahlbr. - C, 1.
O. androgyna (Hoffm.) Arnold - R, 1.
Parmelia saxatilis (L.) Ach. - C, 1, 3.
Parmeliopsis ambigua (Wulfen) Nyl. - CC, 1, 3.
Pertusaria amara (Ach.) Nyl. - R, 2.
Pseudevernia furfuracea var. *ceratea* (Ach.) D. Hawksw. - CC, 3.
* *Saccomorpha icmalea* (Ach.) Clauz. & Roux - C, 1, 6.
* *Trapeliopsis flexuosa* (Fr.) Coppins & P. James - R, 1.
* *Usnea plicata* (L.) Web. ex Wigg. s. lat. - C, 3.

Espèces surtout lignicoles

Buellia griseovirens (Turner & Borrer ex Sm.) Almb. - CC, 4, 5, 2, 3.
! *Calicium denigratum* (Vain.) Tibell - C, 4, 5. Boréal et alpin (Tibell 1976).
C. trabinellum Ach. - C, 5, 4.
Cetraria islandica (L.) Ach. - RR, 5.
Chaenotheca brunneola (Ach.) Müll. Arg. - RR, 5.
C. chrysocephala (Turner ex Ach.) Th. Fr. - R, 4.
C. trichialis (Ach.) Th. Fr. - RR, 4.
* *Cladonia cenotea* (Ach.) Schaerer - R, 6, 1.
C. macilenta Hoffm.- R, 6, 1.
* *C. polydactyla* (Flörke) Sprengel - R, 6, 1.
C. pyxidata (L.) Hoffm. - C, 6, 1.
! *C. sulphurina* (Michx.) Fr. - C, 6, 1. Arctique et haute montagne européenne (Wirth 1980).
Cyphelium inquinans (Sm.) Trevis. - R, 4.
* *Hypocenomyce scalaris* (Ach.) Choisy - RR, 6.
! *H. sorophora* (Vain.) P. James & Poelt - CC, 4. Boréal et alpin (Poelt & Vezda 1981).
H. xanthococca (Sommerf.) P. James & G. Schneider - CC, 4.
Icmadophila ericetorum (L.) Zahlbr. - RR, 6.
! *Lecanora mughicola* Nyl. - R, 4. Alpes, Pyrénées françaises et montagnes de l'Europe (Ozenda & Clauzade 1970).
* *L. piniperda* Körber - CC, 4, 5.
! *L. sarcopidioides* (Massal.) A.L.Sm. - C, 4. Montagnes de l'Europe, Alpes, Pyrénées et le sud du Massif Central (Ozenda & Clauzade 1970).
! *Lecidea subfuscescens* Vain. - C, 4, 2. Norvège et Suède (Santesson 1984).
! *L. turgida* Fr. - C, 4, 5. Boréal, hautes montagnes et Europe subméditerranéenne (Wirth 1980).
* *Micarea denigrata* (Fr.) Hedl. - R, 5.
* *M. lignaria* (Ach.) Hedl. - R, 6.
M. peliocarpa (Anzi) Coppins & R. Sant. - R, 6.
* *M. prasina* Fr. - R, 5.
! *Mycoblastus affinis* (Schaerer) Schauer - R, 4. N Europe, Alpes, Carpates et îles Britanniques (Poelt & Vezda 1977).
M. sterilis Coppins & P. James - R, 4.
* *Mycocalicium parietinum* (Ach. ex Schaer.) D. Hawks. - C, 4.
* *Ochrolechia turneri* (Sm.) Hasselrot - C, 4, 1.
Parmeliopsis hyperopta (Ach.) Arnold - C, 6, 3.
* *Trapeliopsis granulosa* (Hoffm.) Lumbsch. - C, 6, 1.
* *Xylographa abietina* (Pers.) Zahbr. - CC, 5.
! *X. abietina* var. *rubescens* (Räs.) Degel. - C, 5.
* *X. vitiligo* (Ach.) Laundon - R, 5.

Espèces se rencontrant habituellement sur les branches

Alectoria sarmentosa (Ach.) Ach. - C, 3.
* *Bryoria capillaris* (Ach.) Brodo & D. Hawksw. - C, 3.
B. fuscescens (Gyelnik) Brodo & D. Hawksw. - C, 3, 2.
* *Buellia* cf. *zahlbruckneri* Steiner - C, 3.
* *Cetraria pinastri* (Scop.) Gray - R, 3.

Evernia divaricata (L.) Ach. - C, 3.
Hypogymnia physodes (L.) Nyl. - CC, 3, 2, 4, 5, 6, 1.
H. tubulosa (Schaerer) Havaas - CC, 3, 2.
Lecanora pulicaris (Pers.) Ach. - C, 3.
! *L. pulicaris* subsp. *rhododendri* (Harm.) Clauz. et Roux - C, 3, 2, 4. Étage subalpin (Clauzade & Roux 1985).
L. symmicta (Ach.) Ach. - CC, 3, 4.
! *L.* aff. *symmicta*, à thalle sorédié, jaune intense - C, 3.
! *Lecidea pullata* (Norm.) Th. Fr. - C, 3. Boréal et haute montagne de l'Europe (Wirth 1980)
! *Melaspilea proximella* (Nyl.) Nyl. - C, 3. Commun dans l'Europe (Wirth 1980).
* *Micarea misella* (Nyl.) Hedl. - R, 3, 5.
Platismatia glauca (L.) W. Culb. & C. Culb. - CC, 3, 2, 4.
Pseudevernia furfuracea (L.) Zopf. - CC, 3, 2, 4.

Espèces nitrophiles, rares, sur racines exposées

Candelariella xanthostigma (Ach.) Lettau - RR.
Lecidella euphorea (Flörke) Hertel - RR.

REMERCIEMENTS. - Nous tenons à exprimer notre reconnaissance aux Docteurs B.J. Coppins, P. Clerc, A. Vèzda, L. Tibell et E. Barreno, pour la détermination de certaines espèces difficiles, ainsi qu'à l'Exma. Diputación foral de Navarra pour l'attribution d'une bourse universitaire.

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Cryptogamie, Bryol. Lichénol., 1989, 10 (4): 313-317

OPEGRAPHA CELTIDICOLA (JATTA) JATTA NOMBRE CORRECTO PARA *OPEGRAPHA BETULINOIDES* B. DE LESD. Y *OPEGRAPHA THALLINCOLA* B. DE LESD.*

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RESUMEN - El estudio morfológico y anatómico realizado sobre el material tipo de *Opegrapha celtidicola* (Jatta) Jatta, *O. betulinoides* B. de Lesd. y *O. thallincola* B. de Lesd. nos indica que los tres nombres hacen referencia a una misma especie. *Opegrapha celtidicola* es el nombre más antiguo válidamente publicado (Art. 11).

ABSTRACT - The morphological and anatomical studies of the typus-material of *Opegrapha celtidicola, O. betulinoides* and *O. thallincola* show that all of them belong to a single taxon. Consequently the correct name is *Opegrapha celtidicola* because it is the oldest validly published name (Art. 11).

INTRODUCCION

Opegrapha celtidicola, O. betulinoides y *O. thallincola* son tres táxones descritos de la Región Mediterránea Occidental (Italia). Los dos primeros se admiten en distintas floras europeas: Poelt (1969), Ozenda & Clauzade (1970), Clauzade & Roux (1985) y están caracterizados por tener el excipulo abierto en la base y esporas triseptadas de 14-20 x 4-6μm. Las diferencias principales entre las dos especies, en base a las obras citadas, se han resumido en la tabla 1, diferencias que completan las descripciones originales de Jatta (1880) y Bouly de Lesdain (1923).

De *O. thallincola*, conforme con nuestros datos, no existe ninguna referencia posterior a su publicación. Según el protólogo (Bouly de Lesdain 1935), se caracteriza por tener ascocarpos de 0,7-0,8mm de largo, cubiertos de una densa pruina blanquecina, no ramificados, gelatina himenial I+ azul, esporas triseptadas de 15-19 x 4-6μm, conidios rectos (6 x1μm) y hábito parasítico (sobre el talo

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* Financiado por la CAICYT, N.r 0666.84.C2.

de *Schismatomma diplotommoides* = *S. picconianum*). Presenta excípulo abierto, aunque en la descripción original no se hace referencia a ello.

	O. betulinoides	*O. celtidicola*
Talo	poco desarrollado y mal delimitado. K-	bien desarrollado y bien delimitado. K+ amarillo-claro
Pseudotecios	elípticos, alargados, simples, bi- o trifurcados	redondeados, elípticos, raramente alargados, no ramificados
Borde del pseudotecio	delgado y entero	espeso, saliente y a menudo ondulado
Pruina	blanquecina, azulada o sin ella	blanca-grisácea
Himenio	70-80µm. I+ azul-verdoso	80-100µm. I+ azul incoloras
Esporas	pardas al final	incoloras
Conidios	curvados, 6-7 x 1.5µm	rectos, 4-6 x 0.7-1µm

Tabla 1 - Diferencias, según la bibliografía, entre *O. betulinoides* y *O. celtidicola*.

MATERIAL ESTUDIADO

Opegrapha betulinoides **B. de Lesd.**

Typus: (Italia, Liguria) Varazze, ad *Oleam europaeam*, loco "Mola", C. Sbarbaro. IX-1925 (M-Topótipo).

Opegrapha celtidicola **(Jatta) Jatta**

Typus: Italia. Super truncum vetustum *Celtidis australis* prope Portici. Leg. A. Jatta (M-Lojka ex W-Isótipo?); Jatta: Lichenes Italiae Meridion. Ad *Celtidem australem* L. in Portici. Leg. A. Jatta, anno 1980 (M-Topótipo).

ARGELIA: Bejaia. Cap Carbon, 100m, s/ *Phillyrea* sp., *Quercus* sp., 23-III-1986, P. Torrente-I. de Lara (MUB 13026, 13097, 13140, 13083, 13035, 13256, 13159, 13170, 13230, 13537, 13257, 13078, 13435, 13036, 13209).

ESPAÑA: Alicante. Calpe, Peñón de Ifach, BC 4580, 3m, s/ *Pistacia lentiscus*, 19-VI-1987, J.M. Egea (MUB 1385); Denia, Camping Las Rotas, 4m, s/ *Ceratonia siliqua*, 3-V-1986, J.M. Egea (MUB 13111, 13462); Jávea, Cabo San Martín, BC 5994, 50m, s/ *Pinus halepensis*, 1-V-1986, P. Torrente-V. Atienza (MUB 13122, 13118); Jávea, Morró del Pino, Playa Granadella, BC 5691, 130m, s/ *Ceratonia siliqua*, 2-V-1986, P. Torrente-V. Atienza (MUB 13027, 13062, 13093); Formentera, La Mola, s/ *Juniperus phoenicea*, 12-XII-1983, m. Mus. (MUB 13139); Bosque Castillo Bellver, s/ *Olea* sp., M.A. Font. (MUB 13138); Manatxi, Son Veri, s/ *Quercus ilex*. M.A. Font. (MUB 13112, 13094); Port des Canonge, s/ *Ceratonia siliqua*, VII-1986, J.M. Egea (MUB 13210); Puig Massanella, Sierra N, s/ *Quercus ilex*, M.A. Font (MUB 13169); Huelva.

Mazagón, Camping Playa Mazagón, 20-30m, s/ *Pistacia lentiscus*, 14-II-1987, J.M. Egea (MUB 13025). - Valencia. Alzira, Barranco de la Murta, 0m, s/ *Olea europaea*, 26-VI-1981, V. Atienza (VAB 299); La Albufera (Pucko), 0m, s/ *Pinus halepensis*, 8-VI-1983, V. Atienza (VAB 309).

MARRUECOS: Cluses de l'Aïn Maitness près de Boulhaut, s/ *Phillyrea media*, 30-IV-1933, R.G. Werner (BC-Werner). - Kenitra, lagune de Mehdia près Port Lyautey sur *Juniperus phoenicea*, 1-XII-1935, Werner (BC-Werner). - Région de Safi près du Cap Cantin, sur les Oliviers, 2-VIII-1938, Faurel (BC-Werner). - Tanger, Cabo Spartel, 30-100m, s/ *Pistacia lentiscus*, *Olea europaea*, 14-IV-1984, J.M. Egea (MUB 13171, 13153).

PORTUGAL: Algarve. Alvor, Camping Dourada, 50m, s/ *Olea europaea*, *Quercus suber*, *Prunus amygdalus*, *Ficus carica*, 15-II-1987, J.M. Egea (MUB 13001, 13192, 13193, 13272, 13037, 13297, 13130); Ravira, Vila Nova de Cacela, 30m, s/ *Ceratonia siliqua*, 15-II-1987, J.M. Egea (MUB 13200). - Estremadura. Monte Real Olival do Viez, sur écorce de *Olea*, Mai-1943, A.O. Melquiades (BC-Werner); Setubal, umbría de la Sierra de la Arrabida, junto a Cercal de la Sierra, 200m, s/ *Olea europaea*, 18-II-1987, J.M. Egea (MUB 13156, 13223, 13172, 13222).

Opegrapha thallincola **B. de Lesd.**

Typus: in Liguria orientali: Alassio. Ad *Ceratoniam siliquam* XII-1934. C. Sbarbaro. Parasitica supra thallum fertilem *Schismatommatis diplotommoides* (Bagl.) Samp. (M-Isótipo). - Köfaragó-Gyelnik: Lichenotheca n° 108 (M-Isótipo). Alassio (Liguria occid.). Ad Ceratoniam, Loc. class. VIII-1949. C. Sbarbaro (BC-Topótipo).

RESULTADOS

Después del análisis anatómico y morfológico con microscopía óptica del material mencionado en el apartado anterior, se pueden hacer las siguientes consideraciones respecto a las diferencias resumidas, según la bibliografía, en la Tabla 1:

1.- El talo, como en otras especies del género *Opegrapha*, es un carácter que no puede ser tomado como diferencial ya que es muy variable incluso dentro de una misma población.

2.- Los ascocarpos son, en general, redondeados o elípticos y simples como se entendían hasta ahora para *O. celtidicola*; pero junto a ellos se encuentran, en ocasiones, lirelas largas y ramificadas. Cuando el sustrato es madera decorticada los pseudotecios son muy alargados y estrechos y llegan a medir hasta 2,5mm de longitud.

3.- El margen de los ascocarpos, en el material tipo de *O. celtidicola* y *O. thallincola*, es más o menos grueso y saliente. En el tipo de *O. betulinoides* el margen es en efecto delgado ■ incluso llega a desaparecer por completo; sin embargo, en las lirelas jóvenes es relativamente grueso y saliente. En algunos ejemplares se ha visto una variabilidad continua en este carácter.

4. - Tanto los pseudotecios del material tipo de *O. celtidicola* como los de *O. thallincola* están cubiertos por una pruina gris blanquecina. En el tipo de *O. betulinoides* los ascocarpos carecen de pruina o son menos pruinosos. Al estudiar un número elevado de poblaciones se observa que indistintamente en los tres táxones la cantidad de pruina varía.

5.- Las medidas del himenio que hemos obtenido en los tipos son: *O. betulinoides:* 50-75µm, *O. celtidicola:* 50-100 (110)µm, *O. thallincola:* 50-75µm, diferencias que no son significativas.

6.- En el material tipo de los tres táxones hemos observado esporas pardas aunque en *O. celtidicola* de forma menos frecuente. Es general, en *Opegrapha*, que las ascósporas sean incoloras durante gran parte de su desarrollo y sólo al final se vuelven pardas, debido a esto no es raro encontrar ascos con todas las esporas incoloras.

7.- Los conidios, en los ejemplares estudiados incluidos los tipos, son rectos o ligeramente curvados, de 4-6 x 1µm. Puede ser que los de *O. betulinoides* se hayan confundido con los de *Schismatomma picconianum*, especie con la que convive normalmente.

8.- Acerca del hábito parasítico descrito para *O. thallincola*, hay que anotar que más que parásito parece invasor y que este es un carácter común y no diferencial. El tipo de *O. betulinoides* se encuentra sobre el talo de *Schismatomma decolorans*. Además, Bouly de Lesdain (1935: 314) comenta que otro ejemplar de *O. thallincola* recogido sobre olivo parasitaba un talo estéril que, en nuestra opinión, podría claramente corresponder a *S. decolorans* como se confirma en uno de los isótipos. En el resto de material estudiado con frecuencia se ha visto que invade el talo de diversos líquenes que poseen como fotobionte Trentepohliaceae.

CONCLUSIONES

De acuerdo con resultados de este estudio proponemos las siguientes sinonimias:

***Opegrapha celtidicola* (Jatta) Jatta**
Nuovo Giorn. Bot. Ital. 12: 231 (1880).

Basiónimo: *Lecanactis lyncea* var. *celtidicola* Jatta, *Nuovo Giorn. Bot. Ital.* 7: 229 (1875).

Sinónimos: *Opegrapha betulinoides* B. de Lesd., *Bull. Soc. Bot. France* 70: 282 (1923). - *Opegrapha thallincola* B. de Lesd., *Bull. Soc. Bot. France* 82 (5-6): 314 (1935).

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ADDITIONS TO THE BRYOFLORA OF THE PICOS DE EUROPA, OF CANTABRIA AND THE IBERIAN PENINSULA

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ABSTRACT - A list of 39 bryophytes not previously recorded in the Andara Massif of the Picos de Europa mountains in Cantabria is given. *Ulota phyllantha* is reported for the first time from the Iberian Peninsula and *Tortella densa, Riccardia incurvata, Porella arboris-vitae* var. *killarniensis* are reported for the third time. Distribution maps of selected species are given.

RESUMEN - Se da una lista de 39 briófitos recolectados en el Macizo de Andara, nuevos para Cantabria y Picos de Europa. *Ulota phyllantha* se cita por primera vez para la Península Ibérica; *Tortella densa, Riccardia incurvata* y *Porella arboris-vitae* var. *killarniensis* se citan por tercera vez. Se dan los mapas de distribución de las especies menos comunes.

INTRODUCTION

The Picos de Europa mountains are situated in the north-west of the Iberian Peninsula, in the central region of the Cordillera Cantabrica. The eastern massif, Andara, is bounded by the rivers Deva and Duje. The most detailed research was carried out in the north-eastern part of this area which comprises the valleys of the rivers Deva, Urdón, Sobra and Corvera in the administrative area of Cantabria (Fig. 1). The site characteristics have been given in previous papers (Fuertes & Martinez-Conde 1988, 1989).

Each reference to a particular species is accompanied by a number which indicates the site where the species was collected (Fig. 1).

Collections sites:

1. Balneary of La Hermida (100m)
2. The Deva basin between La Hermida and Urdón (80m)
3. The area surrounding the electricity generating station at Urdón (75m).

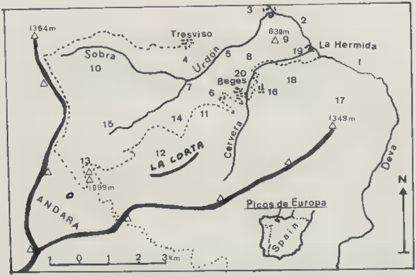

Fig. 1 - Geographic situation of the Picos de Europa in the Iberian Peninsula and locations of the collection sites in Macizo de Andara (Cantabria, Spain).

4. Left bank of the river Urdón (190m)
5. Right bank of the river Urdón (250m)
6. Collado de la Hoja (790m)
7. Salto de la Cabra (710m)
8. Mixed forest (oak, ash, lime) of Sierra de Beges (450-680m)
9. Cuetodave (830m, Sierra de Beges)
10. Valdediezma (Sierra de la Corta, 1300m)
11. El Dobrillo (Sierra de la Corta, 1400m)
12. Monte de la Llama (Sierra de la Corta, 1450-1800m)
13. Minas de Mazarrasa, below the summit of Mancondiu (1999m)
14. Mountain stream "Vau de los Lobos" (1300m)
15. Mountain stream "Vau de las Vacas" (1200m)
16. Quintana (520m)
17. Horcá de Entrelegua (1300m)
18. Varga de los Mollares (450-510m)
19. The Corvera basin (140-190m)
20. The area surrounding Beges (526-600m)

LIST OF SPECIES

Nomenclature follows Grolle (1983) for hepatics and Düll (1984-1985) for mosses. All specimens are deposited in MACB Herbarium.

(1) Species new to Cantabria
(2) Species new to Cantabria and Picos de Europa
(3) Species new to the Iberian Peninsula

HEPATICAE

(1) *Calypogeia azurea* Stotler et Crotz - Abundant on sloping soil. 8, 9, 10, 12.

(2) *Gongylanthus ericetorum* (Raddi) Nees - On damp, acid soils. 7, 8.

(2) *Jungermannia pumila* With. - On soil and acid rocks. 7, 18.

(2) *Mannia fragrans* (Balbis) Frye et Clark - On limestone, on exposed surfaces and in crevices. 3, 5.

(2) *Porella arboris-vitae* (With.) Grolle var. *killarniensis* (Pears.) Corley. - On limestone. 1, 18, 19.

(2) *Riccardia incurvata* Lindb. - On wet limestone. 14.

(1) *Scapania gracilis* Lindb. - On acid soils in mixed forest *(Polysticho-Fraxinetum excelsioris* (Tüxen & Oberdorfer (1958) Rivas-Martinez 1979). 8, 12.

(2) *Targionia hypophylla* L. - On the river bank and crevices of the Urdón basin. 5, 16, 20.

MUSCI

(2) *Bryum elegans* Nees in Brid. - On sloping soil and forest soil. 12, 13.

(1) *B. torquescens* B. & S. - On soil and rocks crevices in forest. 5, 9.

(2) *Campylium polygamum* (B., S. & G.) Lange & C. Jens. - On damp soil. 14.

(2) *Ceratodon conicus* (Hampe ex C. Müll.) Lindb. - On stony soil. 11.

(1) *Cinclidotus mucronatus* (Brid.) Mach. - On temporarily submerged rocks. 1, 2.

(2) *C. riparius* (Brid.) Arnott - On temporarily submerged rocks. 1, 2.

(2) *Dichodontium flavescens* (With.) Lindb. - On shaded rocks in beech wood. 10, 17.

(2) *Didymodon ferrugineus* (Schimp. ex Besch.) M. Hill - On submerged rocks in the river Urdón. 5.

(1) *D. insulanus* (De Not.) M. Hill - On submerged rocks in the river Urdón.5.

(2) *D. spadiceus* (Mitt.) Limpr. - On rocks near the river Deva. 1, 2.

(2) *Drepanocladus aduncus* (Hedw.) Warnst. var. *aduncus* - On soil, in beech wood. 10, 12.

(1) *Entodon concinnus* (De Not) Par. - On rocks and sloping soil. 11

(2) *Entostodon obtusus* (Hedw.) Lindb. - On sloping soil. 11.

(2) *Fissidens pusillus* (Wils.) Milde - On flooded rocks. 1, 2, 3.

(2) *Hypnum lindbergii* Mitt. - On soil in mixed forest. 8.

(1) *Homalothecium aureum* (Lag.) Robins. - Base of limestone rocks. 1.

(2) *Leptobryum pyriforme* (Hedw.) Wils. - In crevices of damp rocks. 12, 14, 15.

(1) *Orthothecium rufescens* (Brid.) B., S. & G. - In rocks crevices. 8, 10, 12, 14, 15.

(2) *Orthotrichum stramineum* Hornsch. ex Brid. - Epiphytic on beech and oak. 8, 9, 10, 12.

(2) *Plagiomnium medium* (B. & S.) T. Kop. subsp. *medium* - In rock crevices. 6.

(2) *Platydictya jungermannioides* (Brid.) Crum - On rocks, in rivers and streams, 3, 5, 7.

(2) *Rhizomnium pseudopunctatum* (B. & S.) T. Kop. - On soil in beech woods and sloping soil exposed to spray by streams. 1, 2, 3, 7, 10, 12.

(1) *Rhynchostegium confertum* (Dicks.) B., S. & G. - On rocks and soil near river beds. 5.

(2) *Tortula inermis* (Brid.) Mont. - On stony slopes. 3, 4.

(2) *T. subulata* Hedw. var. *subinermis* (Brid.) Wils. - At base of rocks and on soil in oak forest. 8, 9.

(2) *Tortella densa* (Lor. & Mol.) Crundw. & Nyh. - In shaded areas in beech woods. 12.

(2) *Ulota coarctata* (P. Beauv.) Hammar - Epiphytic on beech and oak. 6. 10, 12.

(3) *U. phyllantha* Brid. - Epiphytic on beech. 12.

(2) *Weissia controversa* Hedw. var. *crispata* (Nees & Hornsch.) Nyh. - In crevices of limestone. 10, 17.

(2) *Zygodon viridissimus* (Dicks.) Brid. subsp. *baumgartneri* (Malta) Düll - On trunks of trees of decidous forest. 8.

(1) *Z. viridissimus* (Dicks.) Brid. subsp. *viridissimus* - On trunks of trees of deciduous forest. 8.

CARTOGRAPHY

Distribution maps of particular species in the Iberian Peninsula were made using the data given in this paper, in conjunction with information obtained from literature and herbarium sources. U.T.M. (10 x 10km).

Ulota phyllantha Brid. (Fig. 2)

Cantabria: UN 68. Monte de la Llama, E. Fuertes & E. Martinez-Conde, 1983, steril. MACB 20.096.

2

3

4

5

Fig. 2 - Distribution of *Ulota phyllanta* in the Iberian Peninsula. Fig. 3 Distribution of *Tortella densa* in the Iberian Peninsula. Fig. 4 - Distribution of *Riccardia incurvata* in the Iberian Peninsula. Fig. 5 - Distribution of *Porella arboris-vitae* var. *killarniensis* in the Iberian Peninsula.

Tortella densa (Lor. & Mol.) Crundw. & Nyh. (Fig. 3)

Cantabria: UN 68. Monte de la Llama, E. Fuertes & E. Martinez-Conde, 1983, steril. MACB 20.099.

Asturias: UN 48. Covadonga, on limestone, F. Sollman, 1978, steril. BCB 5771.

Lérida: CH 12. Vall de Mulleres, in crevices of limestone, A. Canalis, 1982, steril. BCB 353.

Riccardia incurvata Lindb. (Fig. 4).

Cantabria: UN 69. The Urdón basin, E. Fuertes & E. Martinez-Conde, 1983. MACB 20.100.

Lérida: CH 12. Vall de Mulleres, A. Canalis, 1983. BCB 11. 890.

Palencia: UN 66. Pozo de Curavacas (Cordillera Cantábrica), P. Geissler, 1977 (Geissler 1979).

Porella arboris-vitae (With.) Grolle var. ***killarniensis*** (Pears.) Corley (Fig. 5)

Cantabria: UN 68. Sierra de Beges, on rocks in the oak forest, E. Fuertes & E. Martinez-Conde, 1983. MACB 20.101.

Gerona: DG 52. Riells, C. Casas, 1980. BCB 17.095.

Tarragona: BF 78. Montnegre, R. Cros, 1979. BCB 3993.

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Cryptogamie, Bryol. Lichénol., 1989, 10 (4): 325-335

THE EFFECT OF SOME CHEMICALS ON PROTONEMAL GROWTH AND BUD FORMATION IN THE MOSS *TIMMIELLA ANOMALA*

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ABSTRACT - The effect of some morphactins, vitamins, antibiotics and chelating agents has been studied on protonemal growth and bud formation in *Timmiella anomala*. Morphactins (CME 74050 P and EMD 7461 W) drastically inhibited protonemal growth. Protonemal regeneration occurred only at concentration of 1mg/l, but the filaments produced were sparse and no buds were formed. Vitamins (pyridoxine HCl, cyanocobalamin, riboflavin, thiamine HCl) stimulated bud formation and gametophore growth. The antibiotics, chloramphenicol, penicillin, streptomycin, sulphacetamide and vivocycline had an overall inhibitory effect. Sulphacetamide proved most inhibitory. Ferric citrate at 10mg/l was optimal for bud formation; protonemal growth was not affected, but the length of gametophores increased with increase in concentration of ferric citrate. The chelating agents EDDHA, Fe-EDDHA and EDTA reduced the time required for bud initiation, and increased the number of buds as well as the length of gametophores. The largest number of buds were observed with EDTA and Fe-EDDHA. However, salicylic acid had no marked effect on growth.

INTRODUCTION

In continuation of studies on protonemal differentiation and bud formation in mosses being carried out in this laboratory, the effect of some morphactins, antibiotics, vitamins, ferric citrate and chelating agents on bud induction and gametophore growth in *Timmiella anomala* is described in this communication.

MATERIALS AND METHODS

Timmiella anomala (B., S. & G.) Limpr. was collected from the Manali Hills, Himachal Pradesh, India. Mature, undehisced capsules were surface-sterilized with chlorine water for three to five minutes and then washed repeatedly with sterile water. Spores were squeezed out of the capsules on to a sterile glass slide and planted aseptically on Nitsch's basal medium containing half strength

Knop's major salts (Knop 1865), Nitsch's trace elements solution (Nitsch & Nitsch 1956), ferric citrate (10mg/l), sucrose (1%) and agar (0.8%). The medium was autoclaved at 1.06kg/cm^2 for 15 min., after adjusting the pH to 5.8. The cultures were maintained at 25° ± 2°C and the fluence rate [flux density in the spectral range between 400 and 700nm measured with an ISCO spectroradiometer (model SR, No 80990) at a distance of 27cm from the light source] varied from 10.75 to 12.93 Wm^{-2}.

After the spores germinated, protonema from one of the cultures was multiplied for experimentation; 15-day-old bud-free protonema was used as the inoculum. Ferric citrate, EDTA, EDDHA and Fe-EDDHA were added to the medium before autoclaving. Morphactins (CME 74050 P, EMD 7461 W), vitamins (vitamin B_1, B_2, B_6, B_{12}), antibiotics (chloramphenicol, penicillin, streptomycin, sulphacetamide, vivocycline), and salicylic acid were filter-sterilized (through millipore filters of 0.45μm pore size, Millipore Intertech Inc., Bedford, Massachusetts, USA) and added to the autoclaved medium. Twelve replicates were set up for each treatment, and the experiment was repeated once. Observations of the number of buds formed on the protonema were made under a stereoscopic binocular microscope at regular intervals and the final readings were taken after 40 days of growth. The diameter of each protonemal patch was measured after 30 days by putting it onto graph paper. The length of gametophores was measured after 60 days of growth with a micrometer.

RESULTS

MORPHACTINS

Two morphactins, chlorflurecol-methyl ester (CME 74050 P) and methyl-2-chloro-fluorene-9-carboxylate (EMD 7461 W), were each incorporated into the medium at concentrations of 1, 3, 5 and 10mg/l.

Protonemal regeneration occurred only at 1mg/l. The newly formed filaments were pale-green, sparse, and had a well-developed aerial system. The diameter of the patch was reduced to 4.0 and 5.2mm with CME 74050 P and EMD 7461 W, respectively, whereas in control cultures it was 20.6mm.

No buds appeared with either morphactin, even at 1mg/l. Thus, in this moss, morphactins had a pronounced inhibitory effect on protonemal growth and bud formation.

VITAMINS

Four vitamins (B_1, B_2, B_6 & B_{12}) were individually incorporated into the medium. Vitamin B_{12} was tried at four concentrations (10^{-8}, 10^{-7}, 10^{-6} & 10^{-5}M), while the rest were added at five levels, ranging from 10^{-8} to 10^{-4}M.

Cyanocobalamin (Vitamin B_{12}). - This did not have much effect on protonemal growth at lower levels (10^{-8} - 10^{-6}M). At 10^{-5}M the diameter of the protonemal patch increased (Tab. 1).

Treatment (M)	Diameter of protonemal patch (mm)*	Time taken for bud initiation (days)	Average number of buds/culture*	Average length of gametophores** (mm)	Relative change in	
					No. of buds/ culture	Length of gametophores
					(% of control)	
Control	20.9 ± 0.49	25	26.0 ± 1.55	3.1 ± 0.44	100	100
Vitamin B_{12}						
10^{-8}	21.0 ± 0.50	25	29.8 ± 0.30	3.3 ± 0.39	114.51	106.45
10^{-7}	21.1 ± 0.23	25	32.1 ± 0.25	3.5 ± 0.21	123.46	112.90
10^{-6}	21.1 ± 0.47	20	38.8 ± 0.72	4.2 ± 0.33	149.23	135.48
10^{-5}	25.5 ± 0.52	20	45.8 ± 0.56	3.7 ± 0.39	176.15	119.35
Vitamin B_6						
10^{-8}	20.2 ± 0.28	25	31.1 ± 0.49	3.1 ± 0.73	119.31	100
10^{-7}	19.7 ± 0.47	25	31.4 ± 1.55	3.2 ± 0.03	120.76	103.22
10^{-6}	19.5 ± 0.26	25	36.1 ± 0.72	3.2 ± 0.15	138.86	103.22
10^{-5}	19.5 ± 0.50	25	45.8 ± 0.69	2.5 ± 0.89	176.15	80.54
10^{-4}	14.9 + 0.52	20	51.0 + 0.30	2.2 ± 0.79	196.15	70.96
Vitamin B_2						
10^{-8}	20.4 ± 0.20	20	28.0 ± 0.56	3.2 ± 1.92	107.69	103.22
10^{-7}	19.3 ± 0.24	20	35.8 ± 0.67	3.4 ± 2.12	137.69	109.67
10^{-6}	18.3 ± 0.97	15	25.9 ± 0.54	3.8 ± 1.25	99.61	122.58
10^{-5}	18.0 ± 0.81	15	25.5 ± 0.96	2.4 ± 0.91	98.07	77.44
10^{-4}	17.7 ± 1.20	15	23.2 ± 0.87	1.8 ± 0.89	89.23	58.06
Vitamin B_1						
10^{-8}	21.6 ± 0.65	25	29.4 ± 0.79	3.2 ± 0.79	113.07	103.22
10^{-7}	21.8 ± 0.41	25	29.5 ± 0.57	3.3 ± 0.89	113.34	106.45
10^{-6}	2.3 ± 0.39	25	29.8 ± 0.52	3.4 ± 0.92	114.61	109.67
10^{-5}	1.8 ± 0.38	20	30.1 ± 0.84	2.9 ± 0.89	115.76	93.54
10^{-4}	1.4 ± 0.29	20	30.7 ± 0.89	2.3 ± 0.98	118.07	74.19

*For protonemal patch and bud number, each datum indicates the mean and standard error from 12 replicates.

**For gametophore length, each datum indicates the mean and standard error from 20 gametophores.

TAB. 1. - The effect of vitamins on protonemal growth, bud formation and gametophore length in *Timmiella anomala*, maintained in 10.75 - 12.92 Wm^{-2} of continuous light at 25° ± 2°C.

In the control cultures and at 10^{-8} and 10^{-7}M vitamin B_{12} buds were initiated after 25 days. The time required for bud formation was reduced by 5 days at 10^{-6} and 10^{-5}M. The average number of buds per culture increased linearly with increase in the concentration of this vitamin, 10^{-5}M being the optimum concentration. Gametophore growth was also slightly stimulated by vitamin B_{12}, with an optimum at 10^{-6}M (Tab. 1).

Pyridoxine HCl (Vitamine B_6). - This retarded the growth of protonemal filaments, the inhibitory effect being more pronounced at 10^{-4}M (Tab. 1).

Buds developed after 20 days at 10^{-4}M, whereas at all other concentrations and in the control cultures they were observed after 25 days. Increase in the concentration of vitamin B_6 led to a gradual and linear increase in the number of buds per culture, 10^{-4}M being the optimum concentration. At lower levels (10^{-8} - 10^{-6}M) the length of gametophores was not affected, but higher concentrations proved inhibitory and at 10^{-4}M the mean length of gametophores was reduced to 2.2mm (Tab. I).

Riboflavin (Vitamin B_2). - This inhibited protonemal growth. The diameter of the protonemal patch decreased as the concentration of this vitamin was increased (Tab. I).

The time of appearance of buds was favourably affected. Bud initiation took 25 days in the control cultures; 20 days at 10^{-8} and 10^{-7}M, and 15 days at 10^{-6}, 10^{-5} and 10^{-4}M. The number of buds and the length of gametophores increased at lower concentrations, but decreased at higher levels, 10^{-7}M being optimal for the first of these responses and 10^{-6}M for the second (Tab. I).

Thiamine HCl (Vitamin B_1). - Protonemal growth was enhanced at lower concentrations (10^{-8} - 10^{-6}M) but was inhibited at higher levels (10^{-5} & 10^{-4}M). The diameter of the protonemal patch was greatest at 10^{-7}M.

At 10^{-5} and 10^{-4}M buds appeared 5 days earlier (20 days) than at other concentrations and in the control cultures. The average number of buds per culture increased at all the levels tried, 10^{-4}M being the optimum concentration. The growth of gametophores was stimulated at concentrations up to 10^{-6}M (Tab. I).

A comparison of the numbers of buds produced in response to the four vitamins revealed that maximum increase was observed with vitamin B_6 at 10^{-4}M (196% of control) followed by vitamin B_{12} at 10^{-5}M (176% of control). Vitamin B_2 elicited the optimum response at 10^{-7}M (137% of control), whereas with vitamin B_1 the increase was negligible, the maximum being at 10^{-4}M (118% of the control) (Tab. I).

A comparison of the lengths of gametophores revealed that vitamin B_{12} enhanced growth at all the concentrations tested, whereas, other vitamins (B_1, B_2 & B_6) stimulated growth at lower levels and suppressed it at higher concentrations. However, the optimum level of all the four vitamins was 10^{-6}M. At this concentration the response as a percentage increase of the control cultures was 135 per cent with vitamin B_{12}, 122 per cent with B_2, 109 per cent with vitamin B_1 and 103 per cent with B_6 (Tabl. I).

ANTIBIOTICS

The effect of five antibiotics (chloramphenicol, penicillin, streptomycin, sulphacetamide & vivocycline) was studied.

Chloramphenicol. - This was incorporated into the medium at four levels - 5, 10, 15 and 30mg/l. Protonemal growth was markedly inhibited.

The time of bud initiation was not appreciably affected. At 15 and 30mg/l bud formation was delayed by 5 days. At all other concentrations and in the control cultures buds appeared after 25 days. The number of buds and the length of

Treatment (mg/l)	Diameter of protonemal patch (mm)*	Time taken for bud initiation (days)	Average number of buds/culture*	Average length of gametophores** (mm)	Relative change in Number of buds/culture	Relative change in Length o gametoph
					(% of control)	
Control	20.6 ± 0.68	25	27.4 ± 1.32	3.1 ± 0.78		
Chloramphenicol						
5	9.5 ± 0.40	25	26.8 ± 1.26	2.3 ± 0.66	97.81	74.19
10	8.5 ± 0.50	25	23.5 ± 1.09	1.9 ± 0.68	85.76	61.29
15	7.6 ± 0.50	30	16.9 ± 0.37	1.8 ± 0.66	60.97	58.06
30	5.7 ± 0.40	30	18.1 ± 1.26	1.4 ± 0.68	66.05	45.16
Penicillin						
5	18.7 ± 0.33	25	23.6 ± 0.81	2.9 ± 0.73	86.06	93.54
10	16.3 ± 0.24	25	20.5 ± 0.64	2.9 ± 0.58	74.81	93.54
15	15.8 ± 0.31	25	19.4 ± 1.36	2.5 ± 0.53	70.80	80.64
30	12.7 ± 0.37	25	17.0 ± 1.38	2.0 ± 1.23	62.04	64.51
Streptomycin						
5	10.0 ± 0.78	25	23.8 ± 0.98	2.6 ± 0.85	86.86	64.51
10	8.8 ± 0.93	25	22.9 ± 0.87	2.4 ± 1.52	83.57	83.87
15	8.5 ± 0.85	25	22.7 ± 1.02	2.1 ± 1.31	82.84	77.41
30	7.7 ± 0.61	25	19.8 ± 1.31	1.8 ± 1.01	72.26	67.74
45	6.7 ± 0.31	30	14.6 ± 0.62	1.4 ± 0.52	53.28	50.06
60	6.2 ± 0.72	30	13.4 ± 0.31	1.0 ± 0.62	48.90	45.16
Sulphacetamide						
5	3.5 ± 1.21	30	19.0 ± 2.02	1.7 ± 0.91	69.34	54.83
10	1.7 ± 0.09	35	16.0 ± 1.96	0.28± 0.82	58.39	09.03
15	–	–	–	–	–	–
30	–	–	–	–	–	–
Vivocycline						
5	9.1 ± 2.11	25	17.0 ± 1.86	1.9 ± 1.03	62.04	61.29
10	6.4 ± 0.73	25	16.6 ± 2.50	1.7 ± 1.67	60.58	54.83
15	4.4 ± 0.00	25	12.4 ± 5.24	1.1 ± 0.77	45.25	35.48
30	3.2 ± 0.98	30	9.8 ± 3.83	1.0 ± 0.68	35.76	32.25
45	3.0 ± 0.57	30	6.4 ± 3.16	0.65± 1.01	23.35	20.96
60	2.5 ± 0.69	35	5.4 ± 3.16	0.46± 0.66	19.70	14.83

Other details as in TAB. I

– No growth

TAB. II. - The effect of various different antibiotics on protonemal growth, bud formation and gametophore length in *Timmiella anomala*, maintained in 10.75 - 12.93 Wm^{-2} of continuous light at 25° ± 2°C.

gametophores decreased with increase in the concentration of chloramphenicol. At the highest concentration the gametophores were 1.4mm long, compared with 3.1mm in the control cultures (Tab. II).

Penicillin. - Penicillin (as benzyl penicillin) was added at 5, 10, 15 and 30mg/l. The time of appearance of buds was not altered, but protonemal growth, bud number and length of gametophores were all adversely affected (Tabl. II).

Streptomycin. - Streptomycin sulphate was tried at 5, 10, 15, 30, 45 and 60mg/l. As the concentration was increased the diameter of the protonemal patch decreased drastically. The protonemal filaments turned pale-green, and ramification was very poor.

The time of bud initiation was not altered at lower levels (5-30mg/l), but with higher concentrations (45 & 60mg l) bud formation was delayed by 5 days. Bud number and gametophore length gradually decreased with increase in the concentration of streptomycin (Tab. II).

Sulphacetamide. -Sulphacetamide sodium was added at four levels - 5, 10, 15 & 30mg l. The inoculum did not regenerate on media containing 15 and 30mg/l. At 5 and 10mg l very few protonemal filaments regenerated, and these turned pale-green. The diameter of the protonemal patch was 1.7mm at 10mg l in comparison to 20.6mm in the control cultures.

Very few buds appeared after 35 and 30 days at 10 and 5mg l, respectively. At higher levels no buds were formed. The development of gametophores was also greatly inhibited. At 10mg l sulphacetamide, gemma-like structures appeared and these were only 0.28mm long (Tab. II).

Vivocycline. - This was incorporated at 5, 10, 15, 30, 45 and 60mg l. The diameter of the protonemal patch decreased, the inhibition being directly proportional to the concentration of the antibiotic.

The time of appearance of buds was not affected at lower levels (5-15mg l). At 30 and 45mg l buds were formed after 30 days, and after 35 days at 60mg l, as compared to 25 days in the control cultures. The number of buds and the length of gametophores decreased with increase in the concentration of vivocycline (Tab. II).

In general, the antibiotics tested were inhibitory to protonemal growth and bud formation. All the antibiotics except penicillin delayed the appearance of buds. Sulphacetamide had the greatest inhibitory effect on the growth of protonema and gametophores. A comparison of the relative effect of antibiotics on bud formation (at 5mg l) revealed that in *Timmiella anomala* vivocycline was the most inhibitory (bud number 62.04% of the control), and chloramphenicol the least (97.81% of the control) (Tab. II).

FERRIC CITRATE

Cultures were grown on a medium containing three concentrations of ferric citrate: 10, 20 and 30mg l. Cultures on a medium with 10mg l ferric citrate served as a control.

Protonemal growth was not affected. Buds appeared after 25 days in the control cultures. At 20 and 30mg l they appeared after 30 days. The greatest number of buds was produced at the lowest concentration (10mg l). Ferric citrate also sti-

Treatment	Time taken for bud initiation (days)	Average number of buds/culture*	Average length of gametophores** (mm)	Relative change in Number of buds/culture (% of control)	Relative change in Length of gametophor (% of control)
Ferric citrate					
10 mg/l (control)	25	28.4 ± 2.50	3.2 ± 1.67		
20 "	30	26.3 ± 1.81	3.7 ± 1.74	92.60	115.62
30 "	30	21.2 ± 3.83	4.6 ± 1.54	74.64	143.75
EDDHA					
10^{-7}M	25	29.8 ± 1.23	3.4 ± 0.99	104.92	106.25
10^{-6} "	20	37.0 ± 0.54	3.7 ± 1.00	130.28	115.62
10^{-5} "	30	19.4 ± 2.96	4.5 ± 0.73	68.30	140.62
10^{-4} "	35	15.9 ± 3.16	4.1 ± 0.66	55.98	128.12
Fe-EDDHA					
10^{-7}M	25	29.6 ± 3.24	3.2 ± 1.86	104.22	100
10^{-6} "	25	34.6 ± 1.72	3.4 ± 0.29	121.83	106.25
10^{-5} "	30	31.7 ± 1.91	4.5 ± 0.41	111.61	140.62
10^{-4} "	30	22.6 ± 2.11	1.9 ± 0.59	79.57	59.37
EDTA					
10^{-7}M	20	39.2 ± 1.87	3.6 ± 0.68	138.02	112.50
10^{-6} "	20	43.2 ± 0.93	4.9 ± 0.69	152.11	153.12
10^{-5} "	25	25.9 ± 1.89	3.0 ± 0.79	91.12	93.75
10^{-4} "	30	16.3 ± 2.17	1.6 ± 0.68	57.39	50.00
SA					
10^{-7}M	25	29.8 ± 1.93	3.0 ± 0.25	104.92	93.75
10^{-6} "	25	30.0 ± 1.87	2.8 ± 0.79	105.63	87.50
10^{-5} "	25	30.0 ± 1.43	2.5 ± 0.87	105.63	78.12
10^{-4} "	25	22.3 ± 0.92	2.0 ± 0.98	78.52	62.50

Other details [illegible] in TAB. I

TAB. III. - The effect of various different iron sources on bud formation and gametophore length in *Timmiella anomala*, maintained in 10.75 - 12.93Wm^{-2} of continuous light at 25° ± 2°C.

mulated gametophore growth, the response being directly proportional to concentration (Tab. III).

CHELATING AGENTS

The chelating agents, EDDHA, Fe-EDDHA, EDTA & SA, were each tried at 10^{-7}, 10^{-6}, 10^{-5} and 10^{-4}M.

Ethylenediamine-di(o-hydroxyphenylacetic acid) (EDDHA). - This had no effect on protonemal growth. In the control cultures and at 10^{-7}M buds were formed after 25 days. At 10^{-6}M they appeared after 20 days, but bud induction was delayed by 5 and 10 days at 10^{-5} and 10^{-4}M, respectively.

EDDHA enhanced the number of buds at lower levels, 10^{-6}M being the optimum concentration. It proved inhibitory at higher levels (10^{-5} & 10^{-4}M). The growth of gametophores was stimulated, with an optimum at 10^{-5}M (Tab. III).

Iron salt of ethylenediamine-di(o-hydroxyphenylacetic acid) (Fe-EDDHA). - Protonemal growth remained unaltered at all the concentrations of Fe-EDDHA tried. In the control cultures, and at 10^{-7} and 10^{-6}M buds were formed after 25 days, whereas at 10^{-5} and 10^{-4}M they appeared after 30 days.

Fe-EDDHA enhanced the number of buds at all levels, except 10^{-4}M. The response was maximal at 10^{-6}M. The length of shoots increased in response to Fe-EDDHA up to 10^{-5}M (Tab. III).

Ethylenediaminetetraacetic acid (EDDTA). - This chelating agent also had little effect on protonemal growth, but the time of bud initiation was altered. Buds appeared after 25 days in the control cultures and at 10^{-5}M; after 20 days at 10^{-7} and 10^{-6}M; and after 30 days at 10^{-4}M. The lower concentrations enhanced the number of buds and the length of gametophores, whereas higher levels (10^{-5} & 10^{-4}M) were inhibitory. Both types of responses were maximum at 10^{-6}M (Tab. III).

Salicylic acid (SA). - Protonemal growth and time of bud initiation were not influenced by SA, but the number of buds increased slightly. At 10^{-10}M, SA proved inhibitory. With increase in the concentration of salicylic acid, the length of gametophores gradually decreased (Tab. III).

In general, the chelating agents tested did not have much effect on protonemal growth. At lower levels the time of bud initiation was generally reduced. A comparison of the relative change in the number of buds:culture revealed that the maximum response was observed with EDTA at 10^{-6}M (152% of the control), followed by EDDHA at 10^{-6}M (130% of the control), Fe-EDDHA at 10^{-6} (122% of the control), and SA at 10^{-6} and 10^{-8}M (106% of the control) (Tab. III).

DISCUSSION

In *Bryum klinggraeffii* (Rawat 1976), *Barbula gregaria* and *Bryum coronatum* (Kumra 1981), the morphactin CME 74050 P suppressed protonemal growth, delayed the initiation of gemmae buds, reduced their number and retarded the elongation of shoots. When cultures of *B. klinggraeffii* were kept under field conditions this morphactin induced the formation of many lateral branches and retarded the elongation of shoots. In the present investigation on *Timmiella*, the two morphactins tested (CME 74050 P & EMD 7461 W) strongly inhibited protonemal growth, and buds failed to appear. In contrast to these observations, CME stimulated protonemal growth in *Hymenostylium* and increased bud number in *Microdus* and *Campylopus* (Mehta 1986). In higher plants, morphactins are known to inhibit seed germination and stem elongation, but induce lateral branches (Schneider 1970).

Most tissues cultivated in vitro are capable of synthesizing vitamins. Not much is known about the effects of vitamins on bryophytes. Spiess et al. (1973) reported that in *Pylaisiella selwynii* vitamin B_{12} decreased the time required for bud initiation and increased their number (3 to 20-fold); but that at 10^{-4}M, callus-like masses were formed. In *Pylaisiella* this vitamin mimicks the effect of cytokinin. In *Hyophila involuta* vitamin B_{12} slightly enhanced bud formation at lower levels (Rahbar 1981). Vitamins usually reduce the time taken for bud formation and increase their number, as for example, vitamins B_{12} and B_1 in *Barbula gregaria* and *Bryum coronatum* (Kumra 1981), vitamin B_{12} in *Bartramidula bartramioides* (Rahbar 1981), vitamin B_1 in *Philonotis* (Babbar 1985), vitamins B_1, B_6 and B_{12} in *Microdus* (Mehta 1986), and vitamins B_1, B_2, B_6 and B_{12} in *Timmiella anomala* (present investigation). However, in *Garckea phascoides* bud number decreased at all levels of vitamin B_1 tested (Sarla 1986).

Vitamin B_{12} induced buds in *Dicranella coarctata* (Kumra 1981) and *Bryum atrovirens* (Vashistha 1985). Both these mosses remain bud-free on basal medium.

Antibiotics are useful in the study of morphogenesis since they act as inhibitors of various metabolic processes. Streptomycin and penicillin cause inhibition of protein synthesis (Fitzgerald et al. 1948). However, not much is known about the effect of antibiotics on bryophytes. In *Timmiella* the antibiotics tested (chloramphenicol, penicillin, streptomycin, sulphacetamide & vivocycline) inhibit protonemal growth, and delay the appearance of buds, in addition to reducing their number and decreasing the length of gametophores.

Chelating agents stimulate protonemal growth in some mosses, whereas in others they prove inhibitory (see Sarla 1986). In *Timmiella anomala* (present investigation) protonemal growth is not affected by EDDHA, EDTA, Fe-EDDHA and SA.

Chelates usually increase bud number as for example, Fe-EDDHA in *Barbula gregaria* and *Bryum coronatum* (Kumra 1981), SA, EDDHA, Fe-EDDHA, EDTA in *Bartramidula bartramioides* (Rahbar & Chopra 1983), EDDHA, EDTA and their salts, and SA in *Microdus brasiliensis* (Mehta 1986), SA, EDDHA, EDTA in *Philonotis* (Babbar 1985), EDDHA, Fe-EDDHA, EDTA in *Anisothecium spirale* and *Pohlia elongata* (Vashistha 1985) and EDDHA, EDTA, Fe-EDDHA and SA in *Timmiella anomala* (present investigation).

Chelating agents bring about changes in morphogenetic processes, possibly by affecting the bioavailability of metals such as copper and iron (Seth et al. 1970). Rahbar & Chopra (1983) estimated the endogenous levels of iron and copper in response to chelators by atomic absorption spectroscopy. They observed that the endogenous iron content was maximum at 10^{-7}M EDDHA or EDTA, which is also the optimal concentration for bud induction. In the same way exogenously increased levels of iron and copper stimulated bud induction. The maximum levels of iron and copper were higher in EDDHA-treated cultures than in those supplemented with EDTA. In *Timmiella anomala* (present investigation) bud induction is also increased by iron supplied exogenously as ferric citrate.

A large number of buds were induced by changing the iron source from ferric citrate to (i) Fe-EDDHA in *Anoectangium thomsonii* (Chopra & Rashid 1969), and *Hymenostylium* (Mehta 1986); (ii) to Fe-EDTA in *Bryum pallescens* (Chopra & Sarla 1985); (iii) and to salicylic acid in *Anoectangium thomsonii* (Saxena & Rashid 1980) and *Campylopus* (Mehta 1986). On basal medium, buds were not formed in these mosses. In *Pogonatum aloides* buds were produced only by the synergism of kinetin and IAA (Sood 1975). The addition of Fe-EDDHA further promoted bud formation.

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THE EFFECT OF SOME AMINO ACIDS AND VITAMINS ON GROWTH AND FERTILITY IN MALE CLONES OF THE MOSS *MICRODUS BRASILIENSIS*

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ABSTRACT - Experiments have been carried out on the effects of some amino acids and vitamins on vegetative growth and antheridial formation in male clones of *Microdus*. Among the amino acids tried, aspartic acid and tryptophan inhibited antheridial production and vegetative growth. Methionine stimulated both responses at all levels, but isoleucine did so only at lower concentrations. Vitamins B_6 and B_{12} also increased both responses.

INTRODUCTION

Extensive work has been carried out on the role of amino acids in controlling growth and development in higher plants (see Butenko 1968), but comparable studies on bryophytes, especially on the onset of the reproductive phase, are meagre (see Chopra & Kumra 1988).

This investigation is an attempt to extend studies on growth and antheridial production in male clones of the moss *Microdus*. The effect of aspartic acid, isoleucine, tryptophan, methionine, lysine, threonine and vitamins B_1, B_6 and B_{12} are reported.

MATERIALS AND METHODS

Microdus brasiliensis (Dub.) Thér., a dioecious moss, was collected from Pachmarhi, Madhya Pradesh, India. Aseptic cultures of male clones were raised from spores and maintained as described in an earlier paper (Chopra & Mehta 1987).

The amino acids and vitamins were each tested at five concentrations, ranging from 10^{-8} to 10^{-4}M. The vitamins were filter-sterilized (pore size 0.45μm, Millipore Intertech Inc., Mass., U.S.A.) and incorporated into the autoclaved medium, whereas the amino acids were autoclaved with the medium.

Cultures were observed under a binocular microscope and finally dissected for detailed study. All experiments were run for 60 days. Twelve replicates were set up for each treatment, and each experiment was repeated once.

RESULTS

AMINO ACIDS

Amino acids. - In cultures with lysine and threonine moruloid buds were induced which did not develop into gametophores.

Tryptophan. - Antheridial induction was delayed by 2 days at all levels of this amino acid. The percentage of fertile gametophores produced per culture was

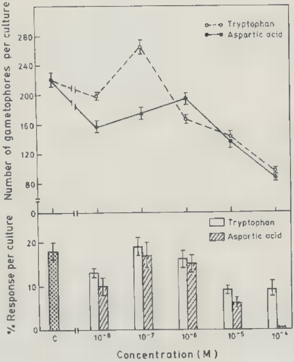

Fig. 1 - The effect of aspartic acid and tryptophan on growth and gametangial formation in male clones of *Microdus brasiliensis*. Per cent response per culture is the percentage of fertile gametophores produced. Each datum indicates the mean and standard error from 12 replicates. The data were recorded from 60-day-old cultures.

markedly reduced at 10^{-8}, 10^{-6}, 10^{-5} and 10^{-4}M. However, at 10^{-7}M no appreciable effect was observed (Fig. 1). Minimal response (50% of the control) was elicited at 10^{-5} and 10^{-4}M. Vegetative growth was stimulated only at 10^{-7}M (Fig. 1). At 10^{-4}M growth was 44 per cent of the control. The number of antheridia per head was not affected by tryptophan. Thus, tryptophan inhibited antheridial production as well as vegetative growth.

Aspartic acid. - The time taken for antheridial production was not altered by aspartic acid. The number of fertile gametophores per culture decreased, and at 10^{-5}M the response was 33 per cent of the control. At 10^{-4}M no antheridia were observed (Fig. 1). The number of gametophores per culture also decreased at all levels of aspartic acid (Fig. 1). The minimum response (at 10^{-4}M) was 39 per cent of the control. The number of antheridia per head was reduced to 7 or 8 as compared to 8-10 in control cultures. Thus, aspartic acid markedly inhibited antheridial production as well as vegetative growth.

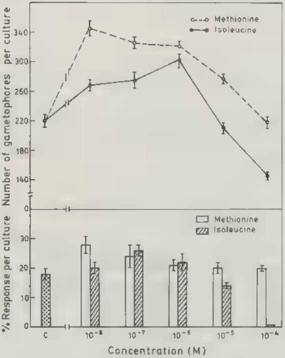

Fig. 2 - The effect of methionine and isoleucine on growth and gametangial induction in male clones of *Microdus brasiliensis*. Per cent response per culture is the percentage of fertile gametophores produced. Each datum indicates the mean and standard error from 12 replicates. The data were recorded from 60-day-old cultures.

Methionine. - Antheridial heads were induced 1 day earlier at 10^{-8} and 10^{-7}M, whereas at the remaining concentrations (10^{-6} - 10^{-4}M) and in the control cultures they appeared after 48 days. The number of fertile gametophores per culture increased at all levels, 10^{-8}M being optimal (Fig. 2). The number of gametophores per culture also increased at concentrations of 10^{-8} to 10^{-5}M. At 10^{-4}M there was no appreciable effect. Maximum vegetative growth was observed at 10^{-8}M (Fig. 2). The number of antheridia per head was not altered by methionine. .

At its optimum level the production of fertile gametophores and vegetative growth were 157 per cent and 156 per cent of the controls, respectively.

Thus, methionine increased antheridial induction and vegetative growth, almost to the same extent.

Isoleucine. - The time taken for antheridial production was not altered by isoleucine. The number of fertile gametophores per culture was enhanced at lower levels (10^{-8} - 10^{-6}M) and decreased at 10^{-5}M. Maximum antheridial production was observed at 10^{-7}M (Fig. 2). At the highest concentration (10^{-4}M) there was no response at all. Vegetative growth increased at lower concentrations (10^{-8} - 10^{-6}M), to a maximum at 10^{-6}M (Fig. 2). The number of antheridia per head remained 8-10.

At its optimum levels, the production of fertile gametophores and vegetative growth were 144 per cent and 137 per cent of the controls, respectively.

Thus, isoleucine promoted antheridial production as well as vegetative growth at lower concentrations.

Of the amino acids tried, aspartic acid and tryptophan inhibited both vegetative growth and antheridial production. At the optimal levels of methionine and isoleucine the number of fertile gametophores was 156 per cent and 144 per cent of the control, respectively. Methionine was also more effective than isoleucine in promoting vegetative growth.

VITAMINS

Thiamine HCl (vitamin B_1). - With this vitamin moruloid buds were induced which failed to develop into gametophores.

Pyridoxin HCl (vitamin B_6). - At lower levels vitamin B_6 increased the percentage of fertile gametophores produced, but the time of antheridial production was not affected. At 10^{-4}M all gametophores remained sterile (Fig. 3). The number of gametophores per culture increased at all concentrations (Fig. 3). The optimal concentration for both responses was 10^{-8}M, and at this level relative enhancement of antheridial production and vegetative growth was 222 and 209 per cent of the controls, respectively. The number of antheridia per head at all concentrations of vitamin B_6, as well as in the control cultures, was 8-10.

Cyanocobalamin (vitamin B_{12}). - Antheridial heads were induced 4 days earlier at 10^{-7} and 10^{-6}M, whereas at other levels (10^{-8}, 10^{-5} and 10^{-4}M) and in the control cultures antheridia were noticed after 48 days. The number of fertile gametophores per culture was enhanced at all concentrations, it being maximum at 10^{-7}M (Fig. 3). Vegetative growth was also stimulated by this vitamin; 10^{-6}M be-

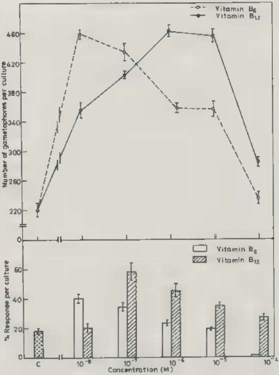

Fig. 3 - The effect of vitamin B_6 and B_{12} on growth and gametangial induction in male clones of *Microdus brasiliensis*. Per cent response per culture is the percentage of fertile gametophores produced. Each datum indicates the mean and standard error from 12 replicates. The data were recorded from 60-day-old cultures.

ing the optimal concentration (Fig. 3). The number of antheridia per head increased at both 10^{-7} and 10^{-6}M, being 10-12.

At its optimal levels the production of fertile gametophores and vegetative growth were 322 per cent and 210 per cent of the controls, respectively. This vitamin was therefore more effective in enhancing antheridial production.

Of the two vitamins, vitamin B_{12} proved more effective in antheridial production than vitamin B_6, but stimulated vegetative growth almost to the same extent.

DISCUSSION

Amino acids generally support good growth in bryophytes. In *Athalamia pusilla* the addition of tryptophan resulted in maximum fresh weight yield and in this it was followed by lysine (Mehra & Pental 1976). In *Riccia crystallina* glutamic acid supported maximum growth followed in order of effectivness of threonine, valine, aspartic acid, hydroxyproline, leucine, serine, tryptophan, asparagine, glycine and alanine (Sood 1974). In *R. gangetica*, out of the six amino acids tried, glutamic acid supported maximum growth and was followed in effectiveness by aspartic acid, glycine, serine, asparagine and tryptophan (Chopra & Kumra 1984). In *R. frostii* tryptophan stimulated vegetative growth only at lower concentrations, whereas aspartic acid and threonine did so at all levels tested (Vashistha & Chopra 1987). In *R. discolor* threonine proved most effective among the amino acids tested, and was followed by lysine, aspartic acid, methionine and asparagine (Sarla 1987). In the present study on *Microdus* aspartic acid and tryptophan inhibited vegetative growth, whereas methionine and isoleucine promoted it. Miller, Garber and Voth (1962) recorded that with a certain combination of amino acids, the growth of *Marchantia polymorpha* was inhibited without any change in morphology. Studies of amino acid-deficient mutants of *M. polymorpha* have proved that endogenous amino acids are involved in the control of growth and development.

The role of aspartic acis is evident from the studies of Margaris (1974) on five moss species. Significantly higher amounts of aspartic acid were recorded in *Tortula princeps* and *Platyhypnidium riparioides*. It is quite possible that, in *Microdus*, the endogenous level of aspartic acid is fairly high and therefore the exogenous supply of this amino acid resulted in the inhibition of vegetative growth.

It has been demonstrated that, in *Marchantia polymorpha*, amino acids affect growth and development by influencing proteins synthesis (Dunham & Bryan 1968, 1969, 1971). A number of essential processes were inhibited in the absence of methionine since this amino acid is associated with chlorophyll biosynthesis (Radmer & Bogorad 1967), ethylene production (Leiberman et al. 1965) and nucleic acid synthesis (Billen & Hewitt 1966), as well as protein synthesis.

Amino acids also influence gametangial production in bryophytes, but their effect is quite variable. In *Microdus* antheridial production is enhanced by methionine and isoleucine, whereas tryptophan and aspartic acid inhibit this response. The number of antheridia per head is also reduced by aspartic acid. Sood (1974) reported that in the monoecious *Riccia crystallina*, glycine, tryptophan and aspartic acid were more effective in increasing the number of antheridia, although archegonial production was also enhanced. In *R. gangetica* (Chopra & Kumra 1984) aspartic acid and glutamic acid increased antheridial formation, whereas asparagine, serine and tryptophan resulted in the production of more archegonia. In the female clone of *R. frostii* aspartic acid, threonine and tryptophan all supported archegonial production (Vashistha & Chopra 1987).

Vitamins also influence growth and development in higher plants. Paris (1955, 1958a, b) and Paris & Duhamet (1953) demonstrated that various tissues synthesize vitamins in suboptimal amounts and that the addition of vitamins to nutrient media improves tissue growth. According to Butenko (1968) thiamine is necessary for the normal growth of *Parthenocissus* crown gall tissue. According to

Reinert & White (1956) vitamin B_{12} is essential for the growth of tumor tissues in *Picea glauca* but has no effect on normal tissues. This may be due to a higher rate of nucleic acid metabolism in tumor tissues, since it is known that vitamin B_{12} participates in the synthesis of purines and pyrimidines.

In bryophytes, vitamins have variable effects on growth. Spiess et al. (1973) reported that, in *Pylaisiella selwynii*, vitamin B_{12} increased the number of buds and, at higher concentrations, resulted in the formation of callus-like masses. In *Riccia discolor* vitamin B_1 and B_{12} supported normal growth and regeneration (Sarla 1987). In *Microdus* vitamins B_6 and B_{12} promoted growth and also enhanced antheridial formation. Of the two vitamins, vitamin B_{12} proved more effective in antheridial production.

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THE RELATIONSHIP OF EPIPHYLLOUS LIVERWORTS WITH LEAF CHARACTERISTICS AND LIGHT IN MONTE VERDE, COSTA RICA

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ABSTRACT - In a study of the ecology of epiphyllous liverworts in a Tropical lower montane wet forest, it was found that the degree of epiphyllic cover and herbivory are generally higher in larger leaves, which indicates that both behave as functions of area. The epiphyllic growth and area consumed by herbivores increase more rapidly than leaf area, and there is no statistical relationship between epiphylly, and herbivory and leaf shape. Absolute and relative epiphyllic cover are higher in the forest clearing than in the understory, perhaps as a result of high atmospheric humidity and occurrence of heliophilic species. This quantitative survey approach is convenient for two reasons: it provides a defined view of actual field conditions and serves as a guide to posterior experimental corroboration.

RÉSUMÉ - L'étude de l'écologie des hépatiques épiphylles en forêt tropicale humide de basse altitude permet de mettre en évidence que le recouvrement par les épiphylles et l'action des herbivores sont généralement plus élevés sur les feuilles larges; ils sont donc fonction de l'aire foliaire. Le développement des épiphylles et l'aire attaquée par les herbivores augmentent plus rapidement que la surface foliaire. Il n'y a pas de relation statistique entre l'épiphyllie, et les herbivores et la forme de la feuille. Les recouvrements absolu et relatif par les épiphylles sont plus importants dans la forêt clairsemée que dans la forêt dense, peut-être à cause d'une humidité atmosphérique plus élevée et de la présence d'espèces héliophiles. Cette approche globale quantitative est utile pour deux raisons: elle permet de définir les conditions actuelles in situ, et elle pourra servir de guide à une confirmation expérimentale ultérieure.

INTRODUCTION

The general ecology of epiphylly is just beginning to be studied. Studies such as those of Winkler (1968) and Olarinmoye (1974, 1976) can be considered pioneering. It is thus difficult to present an overview of current knowledge, but it can be divided into generally accepted and debated conclusions. There is a consensus that microclimatic conditions are of significance in epiphyllae ocurrence, abundance and diversity (Winkler 1968, Olarinmoye 1974, 1976, Richards 1984). Among the debated topics are intra- and interspecific competition, the nature of succession, the relationship between epiphyllae and host plants and the role of light and leaf characteristics (see Richards 1984 for a review). Two causes of this debate are the logistic difficulties that prevent prolonged studies (Winkler 1968) and the non quantitative nature of most research (Olarinmoye 1974, 1976, A. Kjeldberg, personal communication, 1987). This paper presents statistical analyses of the degree of cover by epyphyllae in relation to leaf age, size, shape and herbivory, as well as a comparison between epiphyllous cover from plants growing in a forest clearing and in the understory.

MATERIAL AND METHODS

The area of the Monte Verde Cloud Forest Reserve studied here is located in the tropical lower montane wet forest, in Northwestern Costa Rica. A detailed description is provided by Hartshorn (1983).

The leaf area covered by epiphyllae was estimated with a grid of points (placed every cm), by using two variables: absolute cover or total number of points falling over epiphyllae, and relative cover: number of points falling over epiphyllae divided by total number of points falling over leaf. This second variable is a correction for leaf area. Absolute and relative areas lost to herbivores were evaluated similarly. To estimate number of points falling over missing leaf parts, another leaf of the same species and similar size was placed below. Leaf size was measured with a ruler, and the area was calculated with the formula:

$$\text{AREA} = [(\pi)(X)(Y)] / 4$$

where X = leaf length and Y = leaf width.

Leaf shape was measured by dividing length by breadth, thus, higher quotients indicate longer leaves.

This is a study of degree of epiphyllic cover, not presence; for this reason leaves that had no epiphyllae were excluded.

Leaf characteristics. - A single species of shrub (*Piper* sp.) was used, in order to decrease the number of factors that could affect the results. The host was selected because it is relatively common in the reserve and there were several individuals within a small area (about 50 m^2). The leaves are puberullent with pinnate venation and measure about 9-15 by 3-7 cm. Young leaves were recognized for their lighter coloration, shiny surface devoid of debries and softer texture; no further age estimation was feasible and all leaves not having those characteristics were classified as old.

Forest clearing and understory. - Leaves of all species bearing epiphylls were collected as found, while walking in a forest clearing and in the nearby understory some 15 m away. Voucher specimens are deposited in the Herbarium, Universidad de Costa Rica.

A Spearman Rank Correlation was calculated for each variable pair (significance: * = prob. < 0.05, ** = prob. < 0.01).

RESULTS

The epiphyllae found are leafy liverworts. The systematics of Costa Rican epiphyllae are currently under complete review by Profs. María I. Morales and S. Winkler, and a list of species is not within the scope of this work.

	Sample	Mean	Standard deviation	Minimum	Maximum
Young leaves					
Area	216	74.6	30.3	15.6	165.8
Shape	210	2.8	0.5	0.9	4.2
Relative cover	218	0.3	0.3	0.01	2.7
Absolute cover	218	17.5	17.7	1	78
Relative herbivory	215	0.03	0.1	0	0.6
Absolute herbivory	215	2.0	7.4	0	46
Old leaves					
Area	270	77.8	28	20.1	165.8
Shape	256	2.7	0.5	0.9	4.2
Relative cover	273	0.3	0.3	0.01	2.7
Absolute cover	273	25	25	1	226
Relative herbivory	270	0.04	0.1	0	0.6
Absolute herbivory	270	3	7.5	0	58

Table 1 - Leaf characteristics, cover by epiphyllae and herbivory in young and old *Piper* sp. leaves.

Variable	Old leaves		Young leaves	
	N	Mean Rank	N	Mean Rank
Area**	94	171.4	40	102.2
Relative cover**	95	214.6	40	160.2
Absolute cover**	95	218.4	40	131.4
Relative herbivory**	95	172.5	40	155.2
Absolute herbivory**	95	181.4	40	141.1

**$p < 0.0001$ Mann-Whitney U Test.

Table 2 - Mean rank values for leaf area, cover by epiphyllae and herbivory in old and young *Piper* sp. leaves. N = sample size.

LEAF CHARACTERISTICS

A correlation does not imply the presence of a cause-effect relationship, but the opposite is true (Sokal and Rohlf 1969) and I will firstly mention the variables that were not correlated. In young leaves, the absolute cover is unrelated to leaf shape and to absolute and relative herbivory, as absolute herbivory is unrelated to leaf area and shape and to relative cover. In old leaves, the following variables are independent: area and absolute herbivory and relative cover; absolute herbivory and relative and absolute cover; shape and relative herbivory and relative cover, and relative herbivory and relative cover.

In the young leaves (Table 1), there are correlations between relative cover and area (Contingency Coeficient -0.373**), relative cover and shape (0.302**) and absolute cover and area (0.253*). Leaf shape is also a funtion of area (-0.497**). Most leaves have a low relative cover (Fig. 1a).

Old leaves (Table 1) produced correlations between absolute cover and area (0.583**), absolute cover and shape (-0.290**), relative herbivory and area

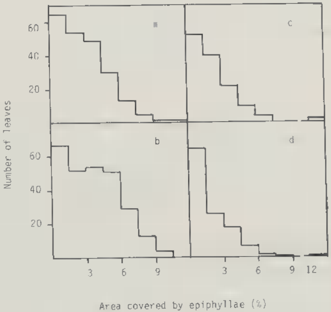

Fig. 1 - Relative cover by epiphyllae on young (a) and old (b) leaves of *Piper* sp., and on leaves of a forest clearing (c) and in the understory (d).

(-0.204*) and area and shape (-0.446**). Most leaves have a low relative cover (Fig. 1b).

When leaves of the two age classes (Fig. 1 a, b) were compared, the six variables were found to differ significantly (Table 2). Area, relative and absolute cover, relative and absolute herbivory are higher in old leaves, which in turn are less elongated (old leaves N = 84, mean rank = 82.4, young leaves N = 38,

	Mean	Standard deviation	Minimum	Maximum
Understory				
Area	65.7	153.2	3.2	0.002
Length	13.7	21.4	2	221
Breadth	6.4	4.3	1.5	45
Shape	2.2	2.7	0.2	24.6
Relative cover	0.1	0.3	0.003	2.4
Absolute cover	7	15	1	77
Clearing				
Area	75.3	80.3	0.8	411.9
Length	16.3	9.6	1	47
Breadth	6.2	2.7	1	13.8
Shape	2.6	1.5	1	7.7
Relative cover	0.2	0.2	0.02	1.3
Absolute cover	15	21	1	113

Table 3 - Leaf characteristics and cover by epiphyllae in a forest understory and a clearing. Sample sizes: N = 120.

Variable	Clearing	Understory
Area	133.9	116.4
Length**	142.4	107.2
Breadth	123.0	178.2
Shape**	149.0	100.1
Relative cover*	135.6	114.5
Absolute cover**	143.2	106.3

*$p < 0.05$, **$p < 0.01$ Mann-Whitney U Test.

Table 4 - Mean rank values for leaf area, length, breadth and shape and cover by epiphyllae in a forest clearing and in the understory. Sample sizes: clearing N = 130, understory = 120.

mean rank = 125.7, $p < 0.0001$). Both young and old leaves have epiphyllae covers below 12 % (Fig. 1 a, b).

FOREST UNDERSTORY AND CLEARING

In leaves collected in the forest understory (Table 3), there are no correlations in all combinations of cover, and shape and herbivory, while there are correlations between area and absolute (Contingency Coefficient 0.20*) and relative (-0.50**) cover. The leaves from the clearing (Table 3, Fig. 1 c, d) showed no correlation between cover, shape and herbivory, although there were also some correlations, as follows: absolute cover and length (0.51**), width (0.40**) and area (0.49**). Length was also correlated with width (0.59**), shape (0.38**) and area (0.88**), as was width with shape (-0.40**) and area (0.87**).

Four variables had higher mean rank values in the clearing than in the forest understory (Table 4): absolute cover, relative cover, length and shape. Most clearing and understory leaves had less than 9 % cover.

DISCUSSION

LEAF CHARACTERISTICS

Leaves of the investigated species tend to elongate and increase their area with age, as normal in many other species (Flores 1989). Leaf area increase is slower than the increase in epiphyllic cover and in area lost to herbivores, since both absolute and relative cover and herbivory are higher in old leaves. This results are consistent with the idea that in epiphyllae there is a strong selection for rapid growth, as discussed by Richards (1984). The concentration of defensive compounds is higher in young leaves (Coley 1987), which would explain why, in this case, the higher proportion of lost lamina occurs in old leaves, although their size is also important: proportionally, larger leaves lose less area.

It has been proposed that herbivory may favour epiphylly (A. Kjeldberg, personal communication, 1987), but this is not true for our data, even when all the combinations of absolute and relative cover and herbivory are tested. This does not appear to be the result of sampling error: this evaluation of herbivory is consistent with that of studies which used more sophisticated measuring devices (Dirzo 1987). Besides, the results shown in the present paper fall within the range known for *Piper* in Costa Rica (Marquis 1987). These measurements of cover by epiphyllae are also in general agreement with those obtained independently by A. Kjeldberg (personal communication, 1987), who used a different method.

Absolute cover with epiphyllae is higher in larger leaves, independently of their age, which supports the idea that cover degree is partially a function of the available area (Winkler 1968, Richards 1984). Epiphyllous cover is strongly associated with age during the first year of leaf life (Winkler 1988, personal communication) and this suggests that our sample consisted chiefly of leaves that were more than one year old. Why longer old leaves have less cover is ignored, but it may be simply the result of another factor which in turn is correlated to leaf shape. Relative cover correlates positively with area and shape only in young leaves, suggesting that larger, younger leaves favour establishment of epiphyllae.

Similarly, epiphyllae seem to be favoured by large leaves, as found in palm leaves in New Guinea and fern fronds in El Salvador (Winkler 1968, Richards 1984).

FOREST UNDERSTORY AND CLEARING

The intensity of light that reaches leaves is variable (Richards 1984) and instead of attempting to measure incident light, I evaluated its effect indirectly by comparing epiphyllae from a clearing and from the forest understory. This non-experimental approach has at least one important disadvantage: concomitant factors such as rain and wind are not excluded and data interpretation becomes more difficult. In the clearing the leaves are more elongated and have a higher mean length. At both sites larger leaves have more absolute epiphyllae cover, but relative cover is higher only in larger leaves of the understory. As age was not estimated for these leaves, it is ignored if it reflects a faster growth of epiphyllae in the understory. Olarinmoye (1974, 1976) listed low air humidity, high light incidence and strong rain as factors that negatively affected epiphyllae. These conditions are expected in the forest clearing rather than in the understory (Richards 1952, Smith 1987), but the results show the opposite: both absolute and relative epiphyllic cover are higher in the clearing. A. Kjeldberg (personal communication, 1987) also found in Monte Verde that those *Piper* sp. leaves which received more sun light had more cover. Among the possible causes for higher cover values in this clearing are the following: a) Olarinmoye's (1974, 1976) studies were done in a strongly seasonal lowland area in Africa and important differences in humidity have been found between lowland and "the much more favourable conditions of the mist" highland forests (Winkler 1968, Richards 1984). In Monte Verde, atmospheric humidity is relatively high throughout the year and should not be a limiting factor, even in forest clearings. b) Some taxa are more heliophilic (Richards 1984) and may require higher amounts of light. Heliophily might result from a need to meet high photosynthetic demands to provide the host with nitrogen, an interesting and overlooked possibility that would explain why more atmospheric nitrogen is fixed in leaves carrying epiphyllae. Such hypothesis is not mutually exclusive with the alternative explanation mentioned by Richards (1984): leaves that bear epiphyllae have a more congenial environment for Cyanophyceae and nitrogen-fixing bacteriae.

CONCLUSIONS

1. The level of epiphylly and herbivory are generally higher in larger leaves, which indicates that both behave as functions of area.
2. Epiphyllic growth and area consumed by herbivores increase more rapidly than leaf area.

3. There is no statistical relationship between epiphylly, and herbivory and leaf shape.
4. Absolute and relative epiphyllic cover are higher in the forest clearing than in the understory.

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SOBRE LA GERMINACIÓN DE LA ESPORA EN *PHAEOCEROS BULBICULOSUS* (BROTHERO) PROSK.

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RESUMEN - Se ha estudiado la morfologia de la espora a SEM y el desarrollo del protonema a partir de la espora de una población de *Phaeoceros bulbiculosus* (Broth.) Prosk., herborizada el 3.V.1979 en el Pto. de Clavín en la Sierra de San Pedro en la Provincia de Cáceres (España). Se sembraron esporas en condiciones de laboratorio siguiendo su germinación y desarrollo durante once meses. Se observó un patrón exospórico con variación respecto a la presencia de tubo de germinación y uniformidad en la emergencia del primer rizoide. Las siembras se realizaron sobre cuatro medios diferentes, dos sólidos y dos liquidos, reseñandose las diferencias morfológicas y de comportamiento de los protonemas y de los gametófitos. Se dió por concluido el seguimiento en fase vegetativa de los talos dorsiventrales.

ABSTRACT - The spore morphology with SEM, the sporeling and the young gametophytes of *Phaeoceros bulbiculosus* (Broth.) Prosk. are studied using specimens collected in Puerto Clavin, Sierra de San Pedro, Province of Cáceres (Spain), stored over eight years. The germination and development of sporelings sown in laboratory conditions were followed for eleven months. An exosporic pattern with variations in presence of germ tube and uniformity in rhizoid development was observed. Four different substrates, two liquid and two solid, were tested. The morphological differences of protonemas and gametophytes growing on each of them are indicated. The experiment ended once the vegetative phase of dorsiventral thallus was attained.

INTRODUCCION

Grönland (1854) realizó las primeras observaciones del patrón de germinación en *Anthoceros* indicando su variabilidad frente a las condiciones ambientales, que posteriormente confirmaron otros autores: Campbell (1913), Casares Gil (1919), Schuster (1966) y Nehira (1983).

Nehira (1983), reuniendo las observaciones de Campbell (1913), Casares Gil (1919), Rink (1935), Mehra & Kachroo (1962) y Renzaglia (1975) reconoció dos modelos básicos en el patrón de germinación de Anthocerotales: protonema cilíndrico de desarrollo exospórico y protonema pluricellular endospórico.

Con este trabajo se pretende, en base a esos estudios, contribuir a conocer la morfología de los diodos, el patrón de germinación y el desarrollo de los gametófitos de *Phaeoceros bulbiculosus* (Broth.) Prosk.

MATERIALES Y METODOS

El material esporígeno procede de ejemplares herborizados en el Puerto Clavin, en la Sierra de San Pedro, en la Provincia de Cáceres, y conservados sin pretratamiento. Un pliego testigo está depositado en el herbario MACB.

La descripción morfológica de las esporas según terminología de Erdtman (1965) y Kremp (1968) reúne las observaciones a microscopio óptico del material embebido en agua y a microscopio electrónico de barrido después de sombreado en alto vacío con una película de oro paladio y posterior metalización.

Todas las medidas se han tomado sobre treinta esporas.

Para el seguimiento de la germinación se sembraron esporas en placas Petri el 4.XII.1987 y el 26.IX.1988. La siembra en medio sólido se realizó sobre una capa de agua de condensación. Los medios de cultivo utilizados fueron: agua destilada, solución de Knop (0.5%), solución comercial nutritiva de Substral (0.07%), agar (1.5%) suplementado con solución de Knop (0.5%) y agar (1.5%) suplementado con solución comercial nutritiva (0.07%) de Substral.

Estos cultivos, cerrados y sellados con parafilm, se mantuvieron en un laboratorio de paredes blancas en orientación W, a una temperatura ambiente y con iluminación natural.

Todos los dibujos se realizaron con la ayuda de una cámara clara.

RESULTADOS

Morfología de la espora

1.- Examen a microscopio óptico: espora polar tetrahédrica de lados convexos en vista distal y color amarillo intenso. Diámetro ecuatorial entre 50 y 70μm y eje polar entre 35 y 50. El valor medio de sus ejes (diámetro ecuatorial 54 y eje polar 43μm) las incluye en el grupo de las esporas grandes.

Algunas aparecían adosadas en tétrades tetrahédricas con un diametro medio de 75μm. Exina lisa, sin ornamentación apreciable. Cara proximal con marca trirrámea que alcanza al margen liso.

2.- Examen a microscopio electrónico de barrido de una tetrade (Fig. 1): superficie escábrida.

Germinación de la espora y desarrollo del protonema

El 4.XII.1987 se siembra en agua destilada el contenido de una cápsula (unas 250 esporas). Los diodos muestran un color verde intenso, sin apreciarse aumento de volumen, poco antes de la germinación. Esta comienza con la protrusión

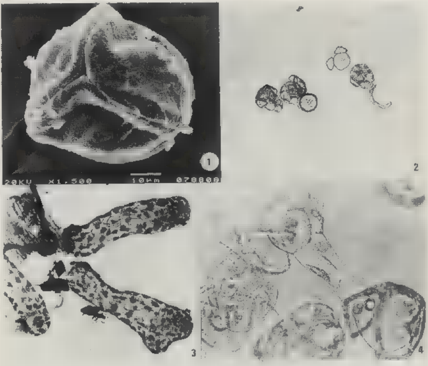
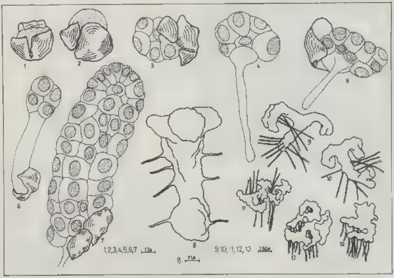


Fig. 1- Vista proximal de una tetrade a MEB mostrando el trilete. Fig. 2: protonema con nacimiento del primer rizoide (115). Fig. 3: protonema dicotomizado (115). 4: Fase protonémica con tubo de germinación y octante celular en el ápice (463).

del contenido celular al producirse la apertura de la pared por el vértice del trilete y separarse tres valvas (Lam. 1: 1, 2).

Dos días después se produce la primera tabicación a la que siguen otras hasta formar un cuerpo ovoideo pluricelular de 6 a 8 células con un gran cloroplasto verde en cada una de ellas (Lam. 1: 3). Tres días más tarde aparece el primer rizoide formado por la elongación, sin tabique de separación, de una célula superficial cercana a los restos de la pared de la espora (Lam. 1: 4, 5 y fig. 2). En este proceso el cloroplasto se fragmenta en pequeñas porciones que pasan al rizoide y posteriormente se desnaturalizan.

Nueve días después de iniciarse la germinación el protonema ya es cilíndrico y lleva aún los restos de la esporodermis adheridos a su base. En este estadio del desarrollo se traslada a Knop líquido donde el protonema, que presenta un máximo de tres rizoides, continúa su crecimiento.



Lamina 1: Germinación de la espora, estadios protonemáticos y desarrollo del gametófito.

Quince dias más tarde el ápice está constituido por un conjunto de células cuneadas de menor tamaño que las periféricas restantes y que al igual que ellas tienen un gran cloroplasto ovoideo parietal (Lam. 1: 7).

Cuarenta dias después de iniciado el proceso, los protonemas, que presentan rizoides lisos en numerosas células de su superficie, son maleiformes e inician una transformación morfológica hacia la dicotomización (Lam. 1: 8, 9, 10 y fig. 3).

Siete dias después de alcanzar esa fase se trasladan a Knop sólido donde continúan su crecimiento sin cambios aparentes hasta que un mes más tarde se conforman como láminas de simetría dorsiventral, que definen la fase adulta a los 75 dias de haberse iniciado la germinación de la primera espora (Lam. 1: 11, 12, 13).

El 26.IX.1988 se efectúa una siembra en cinco medios diferentes, y en dos de ellos, Substral sólido y Knop líquido, aunque es mayoritario el patrón de germinación descrito, se puede observar en algunas esporas la emergencia distal de tubos de germinación que se alargan con emigración de los cloroplastos hacia su ápice, diferenciando una zona hialina basal aislada por un septo. Dos tabicaciones perpendiculares entre si en la célula apical la convierten en un cuadrante de unidades isodiamétricas que cinco días después se transforma en un cuerpo multicelular (Lam. 1: 6 y fig. 4).

Unos protonemas ya cilíndricos, que procedían de esta última siembra en Knop líquido, se fijaron al fondo de la placa manteniéndose postrados y paralelos entre sí desde el 14.XI.1988 hasta la aparición de las primeras dicotomías, sugiriendo un crecimiento orientado.

La vitalidad de las esporas, después de ocho años y diez meses de permanencia en herbario, fue del 90%, indicando una notable longevidad.

DIFERENCIAS EN LA GERMINACION DE LA ESPORA DE *PHAEOCEROS BULBICULOSUS* EN DISTINTOS MEDIOS DE CULTIVO

1.- Tiempo que transcurre entre la siembra y la germinación:

	H_2O	K. liq.	K. sol.	Subs. liq.	Subs. sol.
4.XII.87	40 días				
26.IX.88	11 días	11 días	16 días	19 días	14 días

2.- El porcentaje de esporas germinadas fue del 90% en agua y en Knop líquido; del 40% en Substral sólido y Knop sólido, y del 20% en Substral líquido.

3.- Las esporas sembradas en Substral sólido y en Knop líquido presentaron dos patrones alternativos de germinación: emergencia de tubo o bien de masa pluricelular, sin que aparentemente haya relación con la consistencia del medio empleado ni con cambios de las condiciones ambientales.

4.- Las esporas sembradas en Knop líquido alcanzaron la fase de protonema cilíndrico con tamaño de su eje mayor entre 1000µm y 2000µm, mientras que en el resto de los medios solo llegaron a alcanzar, en algunos casos, una longitud máxima de 200µm siendo el aspecto más frecuente el de un racimo informe de células.

Tres meses después de la germinación solamente continuaban su desarrollo los protonemas en Knop líquido, mientras que se habían paralizado, e incluso degenerado, los que se cultivaban en otros medios.

5.- A los tres meses de las siembras los medios líquidos presentaban contaminación por algas que era muy intensa en Substral e incipiente en Knop. Por el contrario era la fúngica la que invadía los sólidos sin que pareciese perturbar el crecimiento de los protonemas.

DISCUSION

El margen de longevidad, ocho años y diez meses, encontrado en *Ph. bulbiculosus* concuerda con el reseñado para *Phaeoceros laevis* (L.) Prosk. (Proskauer 1957).

Los primeros síntomas de germinación en *Ph. bulbiculosus* han aparecido a tiempos muy distintos, 40 y 11 días, diferencia atribuible unicamente a las distintas condiciones de temperatura ambiental y fotoperiodo entre los meses de las siembras (Diciembre 1987 y Septiembre 1988), ya que la senectud no puede ser responsable al ser más corto el tiempo de germinación empleado por las esporas de la última prueba. Estos datos no presentan diferencias notables con los obtenidos por Mehra & Kachroo (1972) para *A. erectus* Kashyap, de veinticuatro días y *A. punctatus* L., de diez días.

El tipo de dehiscencia y ruptura de la pared esporígena coincide con la de *A. erectus* y *A. punctatus* (Mehra & Kachroo 1962) y *A. fusiformis* Aust. (Campbell 1913).

Un protonema masivo pluricelular ha sido visto en *A. punctatus* (Mehra & Kachroo 1962, Renzaglia 1978), *A. erectus* (Mehra & Kachroo 1962), *A. fusiformis* (Campbell 1913) y *A. crispulus* (Mont.) Douin (Casares Gil 1919), y éste alternando con una germinación por tubo se ha descrito para *A. laevis* (Goebel 1905) del mismo modo que se describe para *Ph. bulbiculosus* en este trabajo. Estas variaciones en Anthocerotales han sido atribuidas por Campbell (1913), Goebel (1905), Casares Gil (1919) y Nehira (1983), a condiciones ambientales fluctuantes.

La aparición del primer rizoide en *Ph. bulbiculosus* es anterior a la formación del protonema cilíndrico multicelular, momento en que citan su aparición en *A. punctatus* y *A. erectus* (Mehra & Kachroo 1962) y *A. fusiformis* (Campbell 1913). Su formación y ausencia de septo de separación coincide con lo observado para *A. erectus* y *A. punctatus* (Mehra & Kachroo 1962) y Anthocerotales en general (Nehira 1983). No se han hallado rizoides ramificados o dicotomizados frente a lo descrito para *A. punctatus* (Mehra & Kachroo 1962, Renzaglia 1978) y *A. erectus* (Mehra & Kachroo 1962).

Peirce (1906) y Proskauer (1948) encontraron en *A. fusiformis* y *A. leavis* L. respuestas fototrópicas coincidentes con la interpretación dada en este trabajo para el comportamiento observado en el crecimiento orientado de *Ph. bulbiculosus*.

En cuanto a la adecuación de distintos medios de cultivo Mehra & Kachroo (1962) encontraron en *Anthoceros* un desarrollo más vigoroso en solución de Knop que en suelo; comparativamente también el Knop liquido resultó ser el mejor de los medios ensayados con *Ph. bulbiculosus*.

CONCLUSIONES

Ph. bulbiculosus presenta la espora polar tetrahédrica grande, con superficie escábrida y trilete que condiciona una abertura ya conocida en otras especies de Anthocerotales (*Anthoceros erectus, A. punctatus, A. fusiformis*).

El amplio márgen de longevidad, ocho años y diez meses, aún siendo alto para una hepática talosa, está dentro de los límites conocidos en Anthocerotales.

La diferencia morfológica en los dos patrones de germinación encontrados, también es coincidente con lo que ya estaba descrito en Anthocerotales, pero no parece obedecer a condiciones extrinsecas en la germinación, sino más bien a causas intrinsecas de la propia espora.

El primer rizoide se forma por protrusión, sin septo separador, de una célula en situación proximal y en fase temprana e informe del protonema.

Si bien el agua destilada da buenos resultados en la germinación, el Knop liquido parece ser el mejor medio de los ensayados para el cultivo de los incipientes protonemas en esta especie.

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Herbiers

Au centre de l'Institut de Botanique, dans des locaux spécialement aménagés en 1967 pour le rangement et la conservation, sont conservées les collections botaniques de W.P. SCHIMPER, H. MUEHLENBECK, WALLROTH et C.G. NEES ab ESENBECK. Pour tout renseignement: Prof. A. Gagnieu et H. Duranton, Lab. Physiol. végét., Institut Botanique, 28 rue Goethe, F-67083 Strasbourg Cedex).

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La présence d'une série de ent-sesquiterpénoides chez *Marchantia polymorpha* suggère une stéréospécificité de la biogenèse des sesquiterpénoides chez les hépatiques et une position taxonomique spéciale de celles-ci dans le règne végétal.

89-376 **PEÑUELAS J. - HCO_3^- as an exogenous carbon source for aquatic bryophytes *Fontinalis antipyretica* and *Fissidens grandifrons*.** *J. Exp. Bot.* 1985, 36(164): 441-448, 5 fig. (Dept. Biol., Univ. Barcelona, Diagonal 645, E-08028 Barcelona).

Seule *Fontinalis antipyretica* est capable d'utiliser HCO_3^- et CO_2 comme source exogène de carbone pour la photosynthèse.

89-377 **ROHWER F. and BOPP M. - Ethylene synthesis in moss protonema.** *J. Pl. Physiol.* 1985, 117(4): 331-338, 3 fig., 3 tabl. (Bot. Inst., Univ. Heidelberg, Im Neuenheimer Feld 360, D-6900 Heidelberg).

La synthèse d'éthylène dépend du stade de développement du protonéma et est lié à l'AIA exogène.

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L'acide sphagnique n'est pas présent en dehors de l'ordre des Sphagnales. Relation entre cet acide et l'activité peroxydase; effet du glyphosate sur la synthèse de cet acide.

89-379 **SATO N. and FURUYA M. - Distribution of diacylglyceryltrimethylhomoserine and phosphati-dylcholine in non-vascular green plants.** *Pl. Sci.* 1985, 38(2): 81-85, 2 tabl. (Dept. Bot., Fac. Sci., Univ. Tokyo, Hongo, Bunkyo-ku, Tokyo 113, Japan).

89-380 **TITUS J.E. and WAGNER D.J. - Carbon balance for two *Sphagnum* mosses: water balance resolves a physiological paradox.** *Ecology* 1984, 65(6): 1765-1774, 3 tabl., 7 fig. (Dept. Biol. Sci., State Univ. New York, Binghamton, New York 13901, U.S.A.).

89-381 **WOODIN S., PRESS M.C. and LEE J.A. - Nitrate reductase activity in *Sphagnum fuscum* in relation to wet deposition of nitrate from the atmosphere.** *New Phytol.* 1985, 99(3): 381-388, 6 fig. (Dept. Bot., The University, Manchester M13 9PL, UK).

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Voir aussi: 89-401.

Répartition, Ecologie, Sociologie

89-382 **BECK E., MÄGDEFRAU K. and SENSER M. - Globular mosses.** *Flora* 1986, 178(1): 73-83, 1 tabl., 8 fig. (Bot. Inst., Univ. Bayreuth, Postfach 3008, D-8580 Bayreuth).
Phytogéogr., taxonomie, structure, physiologie des balles de mousses, lenticulaires à sphériques, sur sols nus, sous conditions climatiques subarctiques.

89-383 **BISANG I. - *Plagiochila exigua* (Tayl.) Tayl. new in Mitteleuropa.** *Herzogia* 1985, 7(1-2): 1-12, 3 fig., 1 tabl. (Syst.-Geobot. Inst. Univ., Altenbergrain 21, CH-3013 Bern).
Descr., écol. de la station du Ticino (Suisse) où a été trouvé *Plagiochila exigua*. Descr. du taxon.

89-384 **COLE M. - Thallose liverworts and hornworts of Costa Rica.** *Brenesia* 1984, 2: 319-348, 15 fig. (College Human Med., Michigan State Univ., East Lansing, MI, USA).
Clé, descr. des genres d'hépatiques et d'anthocérotes avec esp. présentes au Costa Rica. Glossaire.

89-385 **COMPS B., LETOUZEY J. et TIMBAL J. - Etude systématique des hêtraies pyrénéennes et des régions limitrophes (Espagne et Piémont aquitain).** *Phytocoenologia* 1986, 14(2): 145-236, 5 graph., 2 cartes, 23 tabl. (Lab. Bot., Univ. Bordeaux I, av. Facultés, F-33405 Talence Cedex).
Descr. des associations réparties dans les 3 sous-all. du *Fagion*: le *Cephalanthero-Fagenion*, le *Scillo-Fagenion* et le *Luzulo-Fagenion*. Bryophytes associés.

89-386 **DÜLL-HERMANNS I. - Verbreitungskarten von Mooser in Deutschland VI. *Thuidium abietinum* (Hedw.) ■., S. et G. var. *abietinum*, var. *a.* fo. *intermedium* Loeske und var. *hystricosum* (Mitt.) Loeske.** *Herzogia* 1985, 7(1-2): 131-143, 4 cartes (Hochend 62a, D-4137 Rheurdt).

89-387 **GIL J.A. and RUIZ P. - The aquatic basophilous bryophytic communities of South East Spain.** *Herzogia* 1985, 7(1-2): 211-228, 5 tabl., 4 fig. (Dept. Bot., Fac. Ciencias, Univ. Granada, Granada, Spain).
Descr. de 4 assoc. de la classe *Platyhypnidio-Fontinaletea antipyreticae* Philippi 1956, communautés basophiles aquatiques, dans le SE de l'Espgane.

89-388 **GRIMS F. - Beitrag zur Moosfora von Oberösterreich.** *Herzogia* 1985, 7(1-2): 247-257 (Gadern 27, A-4775 Taufkirchen/Pram).
31 hépatiques et 61 mousses nouvelles ou rares de l'Oberösterrecih, avec loc.

89-389 **HÜBSCHMANN A. von - Überblick über die epilitischen Moosgesellschaften Zentraleuropas.** *Phytocoenologia* 1984, 12(4): 495-538, 6 tabl.(Täubnerstr. 8, D-3078 Stolzenau Weser).
Composition, écol., distr. de 50 ass. bryophyt. de l'Europe centrale. Ces communautés épilithiques se divisent en 2 classes: le *Grimmio-Rhacomitrietea* sur rochers siliceux et le *Tortulo-Homalothecietea sericei* sur rochers calcaires.

89-390 **KIENZLE U. - *Origano-Brachypodietum* und *Colchico-Brachypodietum*, zwei Brachwiesen-Gesellschaften im Schweizer Jura.** *Phytocoenologia* 1984,12(4): 455-478, 3 fig., 2 tabl. (Sandweg 30, CH-4123 Allschwil).
Descr. de l' *Origano-* et *Colchico-Brachypodietum*, communautés des prairies du Jura Suisse, au sud de Bâle. Bryophytes associés.

89-391 **KLAWITTER J. - Nachweis von *Bryum barnesii* Wood. in Schimp. in Berlin (West).** *Herzogia* 1985, 7(1-2): 225-298, 1 fig. (Marschnerstr. 22, D-1000 Berlin 45).

89-392 KOLBEK J. - **Málo známá rostlinná společenstva Chráněné krajinné oblasti.** *Preslia* 1985, 57(2): 151-169, 5 tabl., en tchèque, rés. all. et angl. (Bot. ust. ČSAV, 252 43 Pruhonice, Ceskoslovensko).

Descr. de 14 communautés non forestières en Bohême centrale; relevés phytocénol.; bryophytes et lichens associés.

89-393 KRISAI R. - **Ein Beitrag zur Moosflora des Lungaues in Salzburg. Bryologische Ergebnisse der Lungau-Exkursion der bryologisch-lichenologischen Arbeitsgemeinschaft im September 1981.** *Herzogia* 1985, 7(1-2): 191-209, 1 carte (Linzen Str. 18, A-5280 Braunau am Inn.).

Descr. du bassin de Lungau, Autriche SE. Liste des loc., des bryophytes avec loc.

89-394 LIN S.H., TSAI C.C. - **Notes on a preliminary survey of the High Mountain Bryophytes and Lichens in Taiwan - with special reference to the moss floristic relationships between Taiwan High Mountains and adjacent regions.** *J. Taiwan Mus.* 1984, 37(2): 81-100, 1 tabl. (Dept. Biol., Tunghai Univ., Taitung, Taiwan, Rep. China).

Liste de 181 bryophytes et lichens avec loc. des régions de haute altitude de Taiwan. Comparaison de la flore bryol. avec celles du Japon, de l'Himalaya, de la Chine, des Philippines et de Bornéo.

89-395 MAURER W. - **Neue Beitrage zur Moosflora von Steiermark IV.** *Herzogia* 1985, 7(1-2): 299-303 (Kossgasse 11a, A-8010 Graz).

Liste de 27 bryophytes avec loc. en Styrie.

89-396 MEINUNGER L. - **Bryologische Beobachtungen zwischen Ostsee und Ergebirge.** *Herzogia* 1985, 7(1-2): 229-242 (Schottlandstr. 16c, DDR-6406 Steinach).

60 bryophytes nouv. ou intéressants avec loc. de la Rép. Démocratique allemande.

89-397 MENZEL M. - **Katalog der Lebermoose von Peru.** *Willdenowia* 1984 1985, 14(2): 473-523, 1 tabl., 1 fig. (Bot. Gart. & Bot. Mus. Berlin-Dahlem, Königin-Luise-Str. 6-8, D-1000 Berlin 33).

Catalogue de 508 esp. d'hépatiques (avec réf. bibliogr.) d'après la littérature de 1833 à 1983; 67 esp. sont exclues; historique des explorations au Pérou. Notes taxonom. pour certains taxons.

89-398 RISSE S. - ***Pohlia lescuriana* (Sull.) Grout und *Ditrichum pusillum* (Hedw.) Hampe als Ackermoose.** *Natur & Heimat* 1985, 45(2): 41-47, 2 tabl., 2 fig. (Milkdelle 3, D-4300 Essen 1).

89-399 RISSE S. - **Verbreitung epiphytischer Moose am Rande-des Ruhrgebietes (TK 254608).** *Decheniana* 1985, 138: 13-16, 1 fig. (Ibidem).

Cartographie de 32 esp. épiphytes de l'aire de Velbert, bord S de la zone industrielle de la Ruhr.

89-400 SCHÄFER-VERWIMP A. - **Moosvegetation und Moosflora des Naturschutzgebietes Halbinsel Mettnau. .ITAL3 Herzogia** 1985, 7(1-2): 279-294, 1 fig., 1 tabl. (Montfortstrasse 28, D-7993 Kressbronn).

Descr., écol. de la réserve naturelle de Radolfzell (Péninsule de Mettnau) où 75 mousses et 9 hépatiques ont été récoltées. Ecol. de *Scorpidium turgescens*.

89-401 STEINER G. - **Autökologie Studien an Moorpflanzen 1. Charakterisierung der wichtigsten Pflanzensippen oligotroph-saurer Moore auf Grund ihrer Kationengehalte.** *Flora* 1985, 176(1-2): 37-60, 10 fig. (Inst. Pflanzenphysiol., Univ., A-1091 Wien, Althanstrasse 14, PF 285).

Lors de 692 relevés, analyse des contenus en K, Ca, Mg, Mn et Fe de 28 esp. réparties en 9 familles, pour essayer de caractériser les familles des plantes par leurs cations selon les concepts de Duvigneaud et Denaeyer-DeSmet.

89-402 VANA J. - **Notes on some African Hepatic Genera 6-9.** *Folia Geobot. Phytotax.* 1985, 20(1): 81-99, 2 fig. (Dept. Cryptog. Bot., Charles Univ., 12801 Praha 2, Benatska 2, Czechoslovakia).

Notes taxonom., écol. d'hépatiques en Afrique: 3 *Syzygiella*, *Allisoniella nigra* nouv. pour l'Afrique. Résumé des connaissances sur les Gymnomitriaceae en Afrique subsaharienne.

89-403 VIRČENKO V.M. - *Sphagnum* mosses of the Right-Bank Forest-Steppe in the Ukrainian SSR. *Ukrajins'k. Bot. Žurn.* 1985, 42(2): 92-93, en ukrainien, rés, angl. (Inst. Bot. M.G. Kolodnogo, AN URSR, Kiev, USSR).

89-404 WIERSMA P. - Moosflora and vegetation of Saba and St. Eustatius (West Indies). *Proc. Kon. Ned. Akad. Wetenschapen Ser. C Biol. Med. Sci.* 1984, 87(3): 337-348, 4 pl. (Inst. Syst. Bot., Heidelberglaan 2, Utrecht, The Netherlands).

Relations entre les mousses et les communautés végétales à Saba et à St Eustatius, où 48 esp. et 40 esp. respectivement sont présentes. 27 sont communes aux deux îles. Clé aux esp.

Voir aussi: 89-359, 89-360, 89-361, 89-366, 89-367, 89-408, 89-438, 89-442, 89-446.

Pollution

Voir: 89-381, 89-442.

Documentation, Histoire des Sciences

89-405 Anonyme - RNDr. Josef Duda, CSc.-60 let. *Preslia* 1985, 57(2): 180-190, photo.

Notes biographiques et publications depuis 1948 de J. Duda.

89-406 BOREL A. - Centenaire du Jardin Nicolas Boulay. S. l. 1985, 6 p. (605 rue du Pont, Auchy-lès-Orchies, F-59310 Orchies).

89-407 BOREL A. - Jardin Botanique Boulay 1885-1985. Lille: Fac. Libre Sci., juin 1985, 4 p., carte (Ibidem).

89-408 GREENE S.W. and HARRINGTON A.J. - The conspectus of bryological taxonomic literature. Part 2. Guide to national and regional literature. *Bryophyt. Biblioth.* 1989, 37: 1-321 (A.J.H.: Dept. Bot., Brit. Mus. (Nat. Hist.), Cromwell Road, London SW7 5BD, UK).

Références bibliographiques ayant trait à la taxonomie des bryophytes aux niveaux national ou régional et comportant des flores, des listes, des bibliogr., des revues d'exploration ... Il est fait une large sélection des ouvrages les plus à-jour et des publications anciennes essentielles; la plupart des réf. ont moins de 50 ans. Leurs régions et pays, soigneusement délimités, sont placés en ordre alphabétique avec les réf. y afférant. De nombreux renvois permettent de s'y retrouver. Les réf. comportent le plus souvent une brève analyse. Une liste des périodiques et ouvrages bibliogr. dépouillés, un index des auteurs complètent cet excellent guide.

Ouvrages généraux

89-409 LIN S.H. - Introduction to Bryophytes. Taipei: Taiwan Museum, 1988, 78 p., photos coul., en chinois (Dept. Biol., Tunghai Univ., Taitung, Taiwan 40704, Rep. China).

Généralités sur les bryophytes, modes de récolte, caractères gén. des familles avec quelques taxons caractéristiques. Ecologie.

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Systématique, Nomenclature

89-410 BRUSSE F.A. - *Dermatiscum fallax* (Physciaceae), a new lichen from Southern Africa. *Mycotaxon* 1986, 25(1): 161-164, 1 fig. (Bot. Res. Inst., Private Bag X101, Pretoria, South Africa).

Diagn., descr., ill., de *Dermatiscum fallax* sp. nov. d'Afrique du Sud, affine de *D. thunbergii*.

89-411 BRUSSE F. - Two new species of *Parmelia* (Lichenes) from Southern Africa. *South African J. Bot.* 1986, 52: 105-108, 4 fig. (Ibidem).

Diagn., descr., ill., affinité de *Parmelia bibax* et *P. usitata* sp. nov. d'Afrique du Sud.

89-412 GOWARD T. - *Ahtiana*, a new lichen genus in the Parmeliaceae. *Bryologist* 1985 1986, 88(4): 367-371, 1 fig., 2 tabl. (Herbarium, Dept. Bot., Univ. British Columbia, British Columbia V6T 2B1, Canada).

Diagn., descr., ill. d' *Ahtiana* gen. nov. (esp. type: *A. sphaeorosporella* (Müll. Arg.) c.n. (*Parmelia*), isolé de *Parmelia* s.str., phylogénétiquement affine de *Cetraria* s. lat. *Ahtiana sphaerosporella* et son principal phorophyte, *Pinus albicaulis*, ont une distrib. similaire.

89-413 ERIKSSON D. and SANTESSON R. - *Lasiosphaeriopsis stereocaulicola*. *Mycotaxon* 1986, 25(2): 569-580, 5 fig. (Inst. Ecol. Bot., Univ. Umea, S-90187 Umea).

Sphaeria stereocaulicola Lindsay, champignon lichénicole, est transféré sous *Lasiosphaeriopsis* D. Hawksw. & Sivanesan.

89-414 HALE M.E. and AHTI T. - An earlier name for *Parmotrema perlatum* (Huds.) Choisy (Ascomycotina: Parmeliaceae). *Taxon* 1986, 35(1): 133-134 (Dept. Bot, Smithsonian Inst., Washington DC 20560, USA).

Parmotrema chinense (Osbeck) c.n. (= *Lichen chinensis* Osbeck 1757) est le nom correct pour *Parmotrema perlatum* (Huds.) Choisy.

89-415 HALE M.E. Jr. - New species in the lichen family Parmeliaceae (Ascomycotina). *Mycotaxon* 1986, 25(1): 85-93, 12 fig. (Ibidem).

Diagn., descr., ill. de *Bulbothrix australiensis* (Australie), *B. lopezii* (Venezuela), *B. oliveirai* (Brésil), *Hypotrachyna meridensis* (Panama, Guatemala), *Parmotrema betaniae* (Venezuela), *P. catarinae*, *P. fumarprotocetraricum* Marcelli & Hale, *P. lobulatum* Marc. & Hale, *P. madilynae* Flechter et *P. schindleri* du Brésil, *P. sorediiferum* et *P. virescens* du Venezuela.

89-416 HALE M.E. Jr. - *Arctoparmelia*, a new genus in the Parmeliaceae (Ascomycotina). *Mycotaxon* 1986, 25(1): 251-254, 3 fig. (Ibidem).

Le groupe des *Xanthoparmelia centrifuga* est reconnu comme un genre distinct: *Arctoparmelia*, sur la base de critères morphol., chimiques et de répartition. *Parmelia aleuritica*, *Lichen centrifuga* (esp. type), *Lichen incurvesta*, *Parmelia separata*, *P. subcentrifuga* font partie de ce nouveau genre.

89-417 HALE M.E. Jr. - *Flavoparmelia*, a new genus in the lichen family Parmeliaceae (Ascomycotina). *Mycotaxon* 1986, 25(2): 603-605 (Ibidem).

Le genre *Pseudoparmelia* Lynge est limité aux 4 esp. tropicales: *P. cyphellata*, *P. chapadensis*, *P. hypomilta* et *P. sphaerospora*. Sur les 72 esp. assignées à *Pseudoparmelia*, 17 contenant de l'acide usnique (le groupe *P. caperata*) forment le nouveau genre *Flavoparmelia* (digan., descr., 17 comb. nouv.).

89-418 HENSSEN A. BÜDEL B. and NASH III T.H. - Three new species of *Lichinella* described from Mexico. *Bryologist* 19851986, 88(4): 285-292, 31 fig. (Fachber. Biol., Univ. Marburg, D-3550 Marburg.Lahn).

Diagn., descr., ill. de *Lichinella intermedia*, *L. flexa* et *L. robustoides* esp. nouv. du Mexique; comparaison avec les autres taxons du genre. Noter certaines affinités entre *L. intermedia* et *Gonohymenia*. Présence de galles dues à un pyrénomycète lichènicole chez *L. flexa* et *L. robustoides*. Nouv. loc. pour d'autres taxons du genre.

89-419 HENSSEN A. - *Edwardiella mirabilis*, a holocarpous lichen from Marion Island. *Lichenologist* 1986, 18(1): 51-56, 7 fig. (Ibidem).

Diagn., descr., ill. d' *Edwardiella* gen. nov. des Lichinaceae, monospécifique: *E. mirabilis* sp. nov., lichen holocarpe. C'est un lichen *in statu nascendi* dans lequel les colonies de *Gloeocapsa* sont envahies par le mycobionte et se développent directement en apothécie ou en pycnidie. Noter les comb. nouv. : *Gonohymenia nigritella* (Lettau) (= *Thyrea*) et *G. hondoana* (Zahlbr.) (= *Thyrea*).

89-420 SIPMAN H.J.M. - Additional notes on the lichen family Megalosporaceae. *Willdenowia* 1986, 15(2): 557-564, 2 fig.

Descr. de *Megalospora admixta* (Nyl.) (= *Lecidea*) et *M. disjuncta* sp. nov. de Nouvelle-Zélande. Nouveaux synonymes. Extension d'aire pour *M. marginiflexa* var. *dimota* et *M. sulphurata* var. *nigricans*. *M. subtuberculosa* nouv. pour la Nouvelle-Zélande.

89-421 SWINSCOW T.D.V. and KROG H. - A new species in the genus *Collema* from East Africa. *Lichenologist* 1986, 18(1): 63-70, 11 fig. (24 Monmouth Street, Topsham, Exeter, EX3 0AJ).

Diagn., descr., ill. de *Collema laevisporum* sp. nov. de Tanzanie, aff. de *C. callibotrys*.

Voir aussi: 89-423, 89-424, 89-427.

Morphologie, Anatomie

89-422 BURRICK P. and GALUN M. - Spore to spore resynthesis of *Xanthoria parietina*. *Lichenologist* 1986, 18(1): 47-49, 1 fig. (Dept. Pl. Pathol., Univ. California, Riverside, CA 92521, USA).

89-423 KROG H. and SWINSCOW T.D.V. - *Solarina simensis* and *S. saccata*. *Lichenologist* 1986, 18(1): 57-62, 1 tabl., 2 fig. (Bot. Mus., Univ. Oslo, Trondheimsveien 23B, N-0562 Oslo).

Solarina simensis Hochst. ex Flotow diffère de *S. saccata* (L.) Ach. par l'ornementation de la spore, les propriétés chimiques, l'apothécie plane et l'algue bleue en photobionte. Notes à propos de *S. crocoides* (Nyl.) Hue.

89-424 SERUSIAUX E. - The nature and origin of campylidia in lichenized fungi. *Lichenologist* 1986, 18(1): 1-35, 1 tabl., 79 fig. (Dept. Bot., Univ. Liège, Sart Tilman, B-4000 Liège).

Nature et origine des campylidia, structures érigées en forme de casque des lichens foliicoles habituellement nommés *Pyrenotrichum*. L'origine apothéciale de ces structures n'est pas démontrée dans tous les cas. Noter *Loflammia demoulinii* sp. nov. de Nouvelle-Guinée.

Voir aussi: 89-410, 89-411, 89-415, 89-418, 89-419, 89-420, 89-421, 89-448.

Cytologie, Ultrastructure

89-425 **ASCASO C., BROWN D.H. and RAPSCH S. - The ultrastructure of the phycobiont of desiccated and hydrated lichens.** *Lichenologist* 1986, 18(1): 37-46, 3 tabl., 9 fig. (Inst. Edafol. & Biol. Veg., CSIC, Serrano 115 bis, E-28006 Madrid).

Effets de différents traitements de stockage sur l'ultrastructure des phycobiontes de *Lobaria amplissima* (*Myrmecia*) et *Lasallia pustulata* (*Trebouxia*). Résultats discutés en termes d'utilisation et de mobilisation des substances de réserve et des préférences écologiques des 2 lichens.

Physiologie, Chimie

89-426 **BRUNNER U. and HONEGGER R. - Chemical and ultrastructural studies on the distribution of sporopolleninlike biopolymers in six genera of lichen phycobionts.** *Canad. J. Bot.* 1985, 63(12): 2221-2230, 16 fig., 2 tabl. (Inst. Pl. Biol., Univ. Zürich, Zollikerstrasse 107, CH-8008 Zürich).

Méthodes cytol. et chimiques pour déterminer la présence de revêtement trilamellaires et(ou) de polymères résistants dans les parois cellulaires de *Coccomyxa, Elliptochloris, Myrmecia, Pseudochlorella, Trebouxia* et *Trentepohlia*. Présence de couches trilamellaires dans les trois premiers genres, les deux premiers présentant des biopolymères proches des sporopollénines naturelles. Observation de résidus résistant à l'acétolyse proches des sporopollénines dans les cellules entières ou les parois cellulaires des 6 genres étudiés.

89-427 **CULBERSON C.F., CULBERSON W.L. and JOHNSON A. - Orcinol-type depsides and depsidones in the lichens of the *Cladonia chlorophaea* group (Ascomycotina, Cladoniaceae).** *Bryologist* 19851986, 88(4): 380-387, 16 fig., 2 tabl. (Dept. Bot., Duke Univ., Durham, NC 27706, USA).

Mise en évidence de 5 nouv. produits lichéniques (ac. depsidones sténosporonique et divaronique, et ac. meta-depside hyperhomosekikaique, submerochlorophaeique et subpaludosique) dans les esp. du groupe *Cladonia chlorophaea* et dans les genres *Neofuscelia, Parmelia, Ramalina* et *Physcidia*. Structures chimiques par chromatographie et spectrométrie de masse.

89-428 **HANKO B., LEUCKERT C. and AHTI T. - Beiträge zur Chemotaxonomie der Gattung *Ochrolechia* (Lichenes) in Europa.** *Nova Hedwigia* 1986, 42(1): 165-199, 2 tabl. (Inst. Syst. Bot. & Pflanzengeogr., FU Berlin, Altensteinstr. 6, D-1000 Berlin 33).

Chromatographie en couche mince de 600 échantillons d' *Ochrolechia* (16 esp.), spectrométrie de masse et chromatogramme spectral pour la plupart. Composés majeurs: acides gyrophorique, olivétorique, alectoronique, variolarique, lichéxanthone, ac. lichestérinique, murolique et néodihydromurolique. Prépondérance d'ac. alectorialique chez *O. geminipara* qui appartient aux *Pertusaria*. Localisation de l'ac. gyrophorique et de quelques autres composés.

89-429 **LARSON D.W. and CAREY C.K. - Phenotypic variation within individual lichen thalli.** *Amer. J. Bot.* 1986, 73(2): 214-223, 2 tabl., 6 fig. (Dept. Bot., Univ. Guelph, Guelph, Ontario N1G 2W1, Canada).

Variation horizontale de l'activité physiologique ou du phénotype enzymatique dans la largeur du diamètre d' *Umbilicaria vellea* et d' *U. mammulata*. Il est possible que le concept d'individu soit inutilisable pour ces organismes.

89-430 LARSON D.W., MATTHES-SEARS U. and NASH III T.H. - The ecology of *Ramalina menziesii*. II. Variation in water relation and tensile strength across an inland gradient. *Canad. J. Bot.* 1986, 64(1): 6-10, 4 fig., 2 tabl. (Ibidem).

La variation morphologique de *Ramalina menziesii* est le résultat imposé par un environnement qui demeure en permanence humide, frais et salé.

89-431 PÉREZ-URRIA E., LEGAZ M.E. and VICENTE C. - The function of nickel on the urease activity of lichen *Evernia prunastri*. *Pl. Sci.* 1986, 43(1): 37-43, 5 fig., 2 tabl. (Dept. Pl. Physiol., The Lichen Team, Fac. Biol., Complutense Univ., E-28040 Madrid).

Voir aussi: 89-371, 89-416, 89-417, 89-423, 89-439.

Répartition, Ecologie, Sociologie

89-432 CIEŚLIŃSKI S. - Porosty muraw kserotermicznych na kemach w północnej częsci Równiny Bielskiej - The lichens of xerothermic grasslands on kames of the northern part of the Bielsk Plain (North-Eastern Poland). *Fragm. Florist. Geobot.* 19831986, 29(3-4): 435-449, 6 fig., 2 tabl., en polonais, rés. angl. (Dept. Bot., Inst. Biol., Teacher Training College, Kielce, Poland).

Evaluation de la contribution des lichens aux communautés végétales xérothermiques de la classe du *Festuco-Brometea*.

89-433 EL-OQLAH A.A. and LAHHAM J.N. - Lichens from the Northern part of Jordan. *Nova Hedwigia* 1986, 42(1): 201-205, 1 fig. (Dept. Biol. Sci., Yarmouk Univ., Irbid, Jordan).

Liste avec loc. et habitat de 38 lichens en Jordanie N.

89-434 FAŁTYNOWICZ W. - Porosty Bielawskiego Błota-stan aktualny i zmiany po trzydriestu latach dewastacji torfowiska - The lichens of the Bielawiski Bloto peat bog (Northern Poland) - their current state and the changes resulting from thirty years destruction of the peat bog. *Fragm. Florist. Geobot.* 19831986, 29(3-4):415-434, 2 fig., en polonais, rés. angl. (Dept. Pl. Ecol. & Nat. Protect., Univ. Gdańsk, Czolgistow 46, PL-81-378 Gdynia).

En 1981, inventaire de 98 lichens dont 31 sont nouv. pour la région; 21 lichens signalés par Tobolewski en 1954 et 1962 n'ont pas été retrouvés. La lichénoflore est plus riche qu'il y a trente ans. Augmentation due nombre des terricoles du à la disparition de la tourbière. Liste des esp. avec habitat.

89-435 FAŁTYNOWICZ W., BUDZBON E. - Drugie stanowisko *Cetralia nivalis* (L.) Ach. na nizu Polskim - A second locality of *Cetralia nivalis* (L.) Ach. in the Polish lowland. *Fragm. Florist. Geobot.* 1983 1986, 29(3-4): 451-456, 3 fig., 1 tabl., en polonais, rés. angl. (Ibidem).

89-436 GILBERT O.L. and FOX B.W. - A comparative study of the lichens occuring on the geologically distinctive mountains Ben Loyal, Ben Hope and Foinaven. *Lichenologist* 1986, 18(1): 79-93, 5 fig., 3 tabl. (Dept. Landscape Architecture, The University, Sheffield, S10 2TN, UK).

Comparaison des flores lichéniques sur quartzite, granulite Moine, syénite et schistes calcaires dans les Highlands du N de l'Ecosse. Rôle de la minéralogie du substrat, et des conditions climatiques locales. Noter *Lecanora chlorophaeodes* nouv. pour la Grande Bretagne.

89-437 HANSEN E.S. and GRAFF-PETERSEN P. - Lichens growing on the Ella Island meteorite, Central East Greenland. *Lichenologist* 1986, 18(1): 71-78, 6 fig. (Bot. Mus., Univ. Copenhagen, Gothersgade 130, DK-1123 Copenhagen K).

Identification de 10 genres de lichens d'après les thalles et les apothécies mûres ou jeunes dans les fragments de météorites sur Ella Island. La colonisation dépend de la minéralogie et de la chimie de ces fragments. *Xanthoria* préfère ceux ayant des minéraux riches en fer, *Candellaria* pas du tout.

89-438 KENKEL N.C. - Structure and dynamics of jack pine stands near Elk Lake, Ontario: a multivariate approach. *Canad. J. Bot.* 1986, 64(3); 486-497, 8 fig., 3 tabl. (Dept. Pl. Sci., Univ. Western Ontario, London, Ontario, Canada N6A 5B7).

L'analyse multivariable de 180 bosquets de cyprès en site sablonneux permet de déterminer 10 types de végétation appartenant à 5 groupements écologiques. Dynamique. Bryophytes et lichens associés.

89-439 LAMBINON J. et SERUSIAUX E. - Le genre *Xanthoparmelia* (Vainio) Hale (Lichens) en Begique et dans les régions voisines. *Bull. Soc. Roy. Bot. Belgique* 1985, 118(2): 205-211, 4 fig. (Dept. Bot., Univ. Liège, Sart Tilman, B-4000 Liège).

Clé , données phytogéogr. et chimiques des 5 *Xanthoparmelia* présents en Belgique.

89-440 LIPNICKI L. - Nowe stanowisko *Icmadophila ericetorum* (L.) Zahlbr. na Pomorzu Zachodnim - A new locality of *Icamdophila ericetorum* (L.) Ach. in Western Pomerania. *Fragm. Florist. Geobot.* 19831986, 29(3-4): 457-459, 1 fig., en polonais, rés. angl. (Dept. Taxonom., Pl. Geogr. & Nat. Protect., Mikolaj Kopernik Univ., Gagarina 9, PL-87-100 Torun).

89-441 NIMIS P.L. - Phytogeography and ecology of epiphytic lichens at the Southern Rim of the Clay Belt (N-Ontario, Canada). *Bryologist* 19851986, 88(4): 315-324, 9 fig., 2 tabl. (Dept. Biol., Sez. Geobot. & Ecol. veg., Cas. Università, I-34100 Trieste).

Descr. de 8 types de communautés lichéniques épiphytes à partir de 102 relevés dans la région d'Elk Lake (Ontario N). Importance du pH. Interrelation phytogéogr. et écol. Comparaison avec les Alpes Carniques (Italie).

89-442 PENTECOST A. and ROSE F. - Changes in the cryptogam flora of the Wealden sandrocks, 1688-1984. *Bot. J. Linn. Soc.* 1985, 90(3): 217-230, 3 fig., 2 tabl. (Dept. Biol. Sci., Chelsea College, Univ. London, Hortensia Road, London SW10 0QX).

Inventaire de 29 algues, 90 lichens, 165 bryophytes et 8 fougères, dont 18 lichens, 21 bryophytes et 1 fougère n'ont pas été relocalisés depuis 300 ans. La pollution et les changements microclimatiques sont les responsables du déclin de la flore cryptogamique.

89-443 PIERVITTORI R. - Popolamenti lichenici epifiti: bois de la Tour, Saint-Nicolas (Aosta). *Rev. Valdôtaine Hist. Nat.* 1984, 38: 83-88, 2 tabl., 1 fig. (Dept. Biol. veg., Univ., Viale P.A. Mattioli 25, I-10125 Torino).

Végétation lichénique corticole des formations xériques épiphytes sur *Pinus sylvestris* et *Picea abies* du bois de la Tour de St Nicolas (val d'Aoste), Appartenant à l'alliance *Usneion barbatae*.

89-444 PIŠÚT I. - Die aktuelle Verbreitung einiger epiphytischen Flechtenarten in der Slowakei. I. *Sborn. Slov. Nar. Múz. Prír. Ved.* 1985, 31: 3-26, 10 fig. (Slovenske narod. muz., Prir. ustav, Csc- 814 36 Bratislava).

Distribution en Tchécoslovaquie de : *Hypogymnia physodes, Lecanora conizaeoides, Lobaria amplissima, L. pulmonaria, Menegazzia terebrata, Parmelia contorta, P. quercina, Ramalina farinacea, R. fraxinea* et *Scoliciosporum chlorococcum*.

89-445 PIŠÚT I., LIŠKA J. - Lišajníky Slanských Vrchov. *Sborn. Slov. Nar. Muz., Prir. Ved.* 1985, 31: 27-57, en tchèque, rés. allemand (Ibidem).

Végétation lichénique, écol., liste des lichens avec loc. en Slovaquie Ouest.

89-446 SCHUHWERK F. - Kryptogamengemeinschaften in Waldassoziationen - ein methodischer Vorschlag zur Synthese. *Phytocoenologia* 1986, 14(1): 79 108, 5 fig., 12 tabl. (Holzgartenstrasse 58, D-8400 Regensburg).

Intégration des thallophytes épiphytes au même titre que les macrophytes dans les phytocénoses des forêts.

89-447 VERSEGHY K., FARKAS E. - Untersuchungen der Luftverunreinigung im Gebiet von Budapest mit Hilfe der Flechtenkartierung als Indikatoren. *Ann. Univ. Sci. Budapest Rolando Eotvos Nom. Sect. Biol.*, 1984 1986, 34-36: 163-184, 5 fig., 3 tabl. (Bot. Abt., Naturwissensch. Mus., Budapest).

Liste des lichens de Budapest et relation avec la pollution industrielle.

89-448 **WILHELM G. and LADD D. - Macrolichenflora of Jackson County, Illinois.** *Trans. Illinois Acad. Sci.* 1985, 78(3): 209-232.

Clé, habitat, descr., abondance des 84 macrolichens de Jackson County; brève descr. des 25 lichens nouv. pour le comté.

Voir aussi: 89-392, 89-394, 89-410, 89-411, 89-412, 89-415, 89-418, 89-419, 89-420, 89-421, 89-424.

Pollution

89-449 **FARKAS E., LÖKÖS L., VERSEGHY K. - Lichens as indicators of air pollution in the Budapest agglomeration, I. Air pollution map based on floristic data and heavy metal concentration measurements.** *Acta Bot. Hung.* 1985, 31(1-4): 45-68, 17 fig., 5 tabl. (Inst. Ecol. & Bot., Hung. Acad. Sci., Vacratot, Hungary).

Carte des zones de pollution selon la distr. des lichens épiphytes; comparaison avec la carte de pollution SO_2 et distribution des lichens d'il y a 70 ans. Etude de la concentration en Pb, Cd, Mn et Zn. Budapest ressemble à un désert lichénique en raison de la pollution par le Pb et SO_2.

Voir aussi: 89-442, 89-447.

Documentation

89-450 **TIBELL L. and GIBSON C.J. - Bower decoration with *Usnea* species in the Golden Bower Bird.** *Lichenologist* 1986, 18(1): 95-96, 1 fig. (Inst. Syst. Bot., Univ. Uppsala, P.O. Box 541, S-75121 Uppsala).

INDEX DU TOME 10

Compilé par D. LAMY

Il ne figure que la première page de l'article dans lequel est cité le taxon. Les nouveautés taxonomiques sont indiquées en gras. Les taxons cités en synonymie ou comme basionymes sont indiqués par "syn." ou "bas." Lorsque le numéro de la page est suivi d'un nom de région, le taxon est considéré comme nouveau pour celle-ci (ex. Acaulon triquetrum, 289 Navarre).

Bryophytes

Lichens

TABLE DU TOME 10

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MONTAGNE C., 1838 - Centurie des plantes cellulaires exotiques nouvelles; *Ann. Sci. Nat., Bot.*, 2, 9: 38-57.

NEES VON ESENBECK C.G., 1836 - Hepaticae. *In:* Lindley J., A natural system of Botany... Ed. 2. London. Pp. 412-414.

WATSON E.V., 1971 - The structure and life history of bryophytes. Ed. 3. London: Hutschinson University Library. 211 p., 26 fig.

TEXTE. - La présentation du texte devra faire apparaitre clairement ses subdivisions et leur hiérarchie ainsi que le début des paragraphes. Les noms des auteurs qui suivent les binômes latins devront être abrégés selon G. Sayre et al., 1964 *(The Bryologist* 67 (2): 113-135). Les renvois à la liste bibliographique se feront par le nom de l'auteur et l'année de publication (ex.: (Dubois 1980) ou Dubois (1980) et non par les renvois numériques. La place des illustrations devra être indiquée dans la marge. Les notes infrapaginales sont à éviter.

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